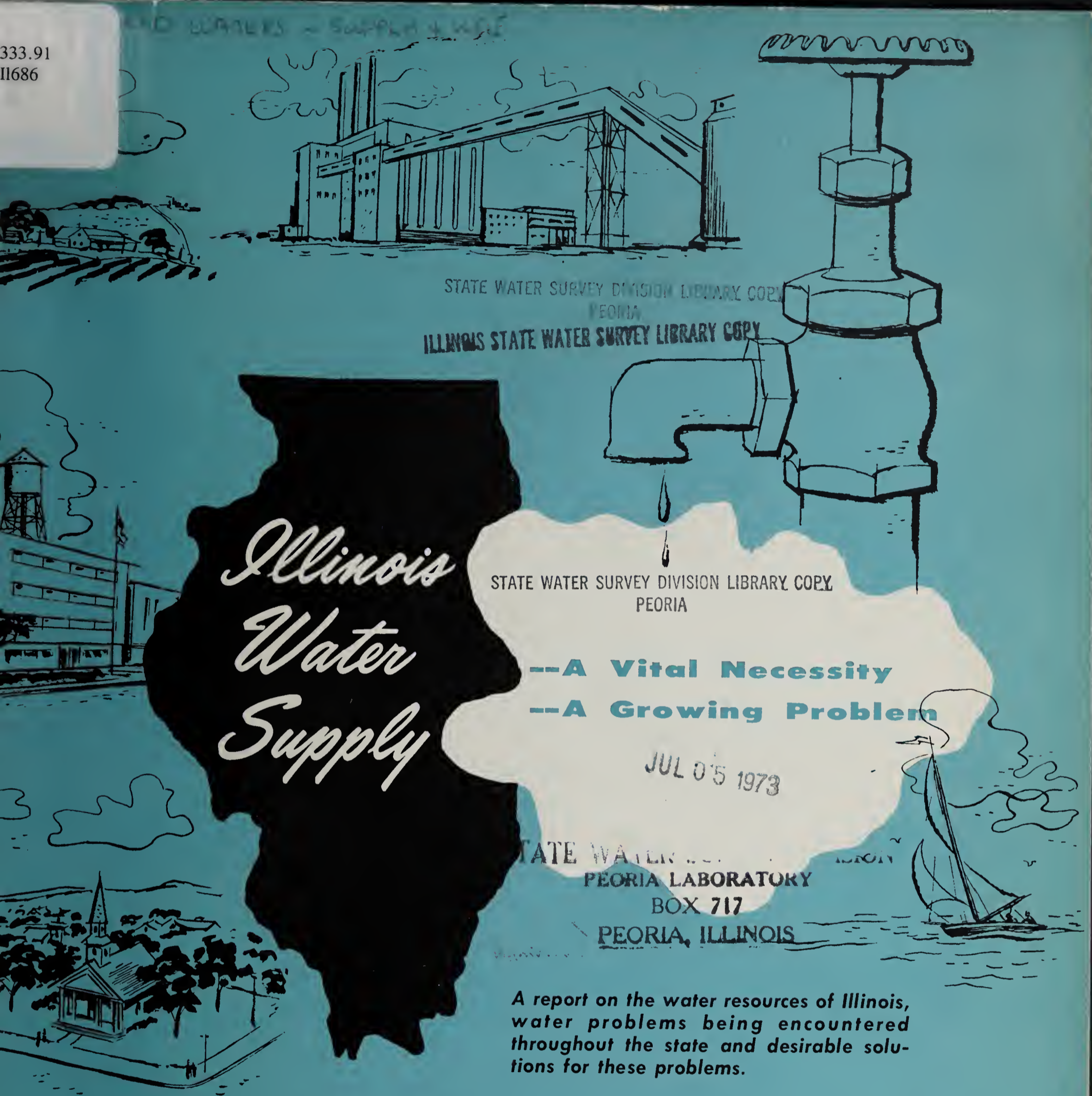


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# Illinois Water Supply

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--A Vital Necessity  
--A Growing Problem

JUL 05 1973

STATE WATER SURVEY DIVISION  
PEORIA LABORATORY  
BOX 717  
PEORIA, ILLINOIS

A report on the water resources of Illinois,  
water problems being encountered  
throughout the state and desirable solu-  
tions for these problems.

water resources committee

ILLINOIS STATE CHAMBER OF COMMERCE

Dear Member:

Water is our most precious resource and a vital necessity for municipal, industrial and agricultural growth. There is no substitute for water, and adequate supplies are a basic requirement for maintaining and improving the high standard of living we have achieved.

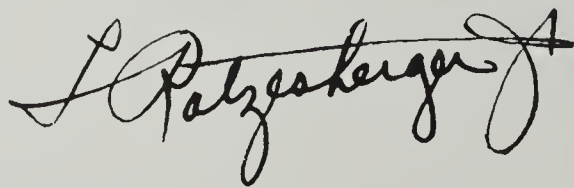
Because we have never individually suffered for any prolonged lack of water, we have grown to take its availability for granted. However, even temporary shortages or discontinuance of water service can cause considerable difficulty, expense and inconvenience.

Increasingly greater problems being encountered in developing adequate water supplies in many parts of Illinois make it imperative that business and community leaders review their local situations in order to solve current problems and to avoid serious difficulties in the near future. Growing populations, intensified agricultural, domestic and industrial use, and other developments are expected to increase tremendously the amount of water needed for various purposes in the next few years.

Illinois communities, farmers and industries that fail to take the steps necessary to solve the difficulties they now or soon will face will find their efforts to progress seriously handicapped. There are few problems for which solutions must be gained so far in advance of their actual appearance in order to avoid difficulty as those related to our water resources. These problems are serious ones, but they are not without solution. They will require the prompt attention of the leaders of every community. A carefully chosen committee of authorities on water supply matters was formed by the State Chamber earlier this year to provide leadership and guidance to local efforts and to work for state legislation and administrative action needed in this field.

This report was designed to provide State Chamber members with a broad, general outline of basic information on the nature and extent of our water resources, major water uses, water problems facing our state and some desirable courses of action which can be taken to solve these difficulties. I urge you to read the report carefully and call it to the attention of other leaders in your community. Some of the problems and solutions outlined may well apply to your own business or to the area in which you live. It is your duty and that of other businessmen and community leaders to become better informed in this field and to assume the leadership needed to effect desirable remedial action in your area and to support efforts to solve problems of a state-wide nature. It was with this need for action in mind that this report was prepared.

Sincerely yours,



Louis Ratzesberger, Jr.  
President

August, 1956

# *Some Significant Facts*

## **about our water resources**

- ★ Water Supply Problems are Distinctly Local but Affect the Entire State
- ★ Agricultural, Industrial and Municipal Users are Affected
- ★ Water Needs are Rapidly Increasing
- ★ Water Supplies are Limited
- ★ Water Problems Stem from Droughts and Other Unfavorable Natural Conditions, Inadequate Facilities, Excessive Use, Pollution, Erosion and Sedimentation, and Lack of Legal Control
- ★ Water and Soil Conservation Problems are Inter-related
- ★ Prompt Attention to the Problems is Essential to Continued Progress
- ★ Effective Local Action Can Solve Many of Our Difficulties
- ★ State Government Attention to Matters of a State-wide Nature is Needed



## **Summary of Recommendations for Solution of State Water Problems**

**Increased Practice of Soil and Water Conservation in the Upper Watersheds  
of Illinois Streams and Rivers**

**Municipal Action to Meet Current and Future Needs Based on Comprehensive  
Study of Local Problems and Directed by Competent Technicians**

**Greater Industrial Attention to Water Conservation and Pollution Abatement**

**Action by the State Government**

- 1. The Illinois General Assembly Should Authorize and Provide  
Funds for a Thorough Survey of Illinois Water Resources, Uses  
and Problems and Agencies Dealing with These Problems.**
- 2. No Legislation Relating to Water Rights Should be Enacted  
Unless a Thorough Study of This Problem is Made and the  
Interests of All User Classes Considered.**

**Local Initiative and Autonomy in Water Resources Planning, Development  
and Control Should be Maintained and Encouraged**

# ILLINOIS WATER SUPPLY

## WHAT IS THE ILLINOIS WATER PROBLEM?

Illinois is not an arid state and does not suffer from an absolute shortage of water or of sources of supply. The problem now being encountered more frequently is that of having the right amount of water, of proper quality, at the right time and place. There is no single state-wide water problem. Rather, there are many different problems affecting various areas and user classes within these areas.

Many news items in recent months and during the drought which affected areas in central and southern Illinois between 1952 and 1955 have highlighted the problems of water shortage. Even though many of the symptoms have been eliminated by rain and temporary remedial measures, the basic problems which complicated the situation during the drought are still present. Unless immediate attention is given to these difficulties, many localities will again face critical situations in the near future.

Several basic problems exist in addition to water shortages and drought, however. These problems are of concern to the entire state. The increasing demand for water by an expanding and more demanding population has already drawn attention to those areas without favorable natural conditions from which large supplies can be developed. This demand will increase progressively and will necessitate giving greater attention not only to the many problems related to adequate water supply but also to floods, pollution, erosion and sedimentation, and water rights.

## ILLINOIS WATER RESOURCES

Approximately 2,000 billion gallons of water pass over Illinois daily in the atmosphere in the form of clouds or unseen vapor. Most of this atmospheric moisture is brought by tropical air which gains its moisture content over the Gulf of Mexico and southward. A general pattern indicates that the greatest part of the atmos-

Figure 1. The world of water.

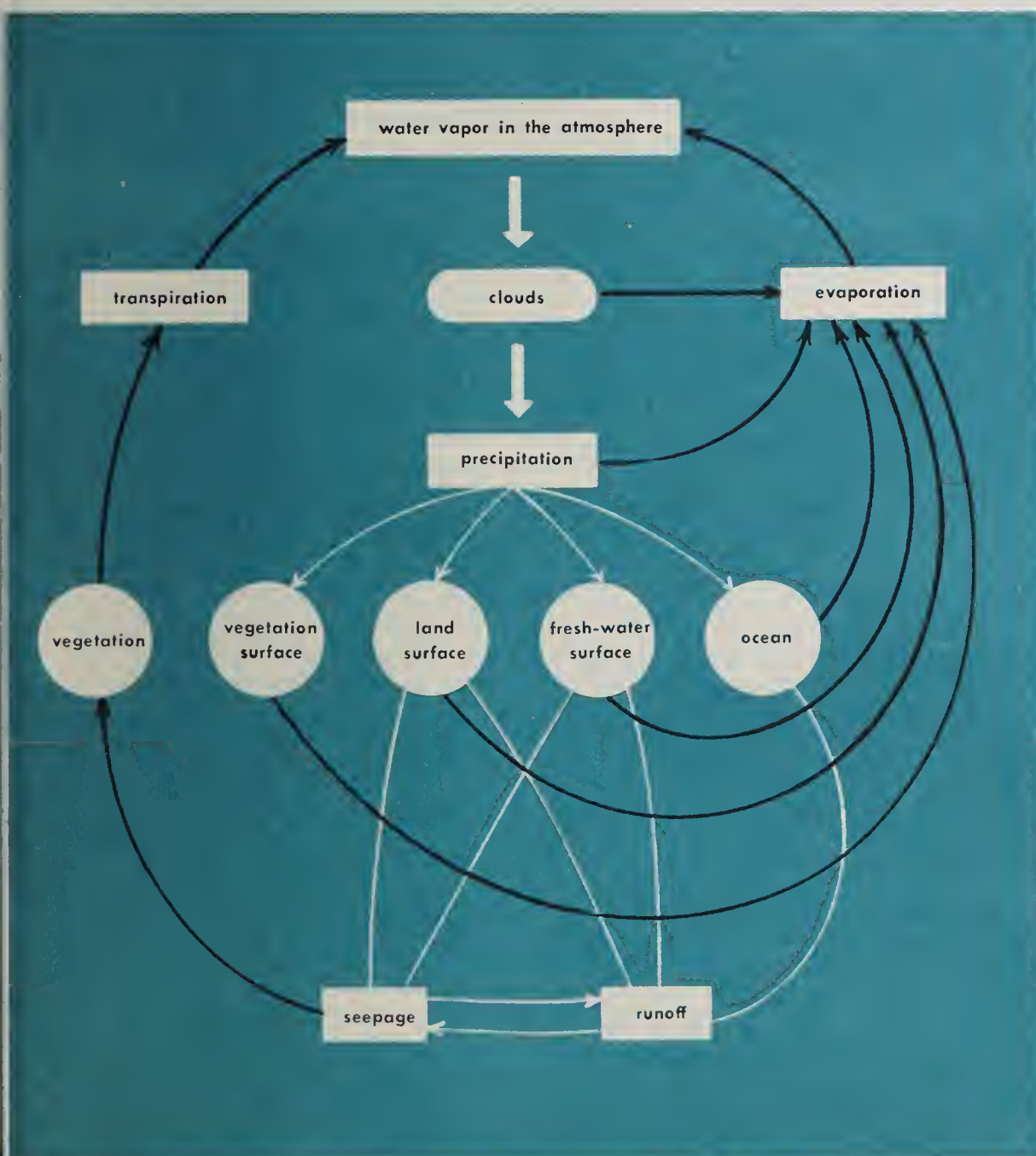
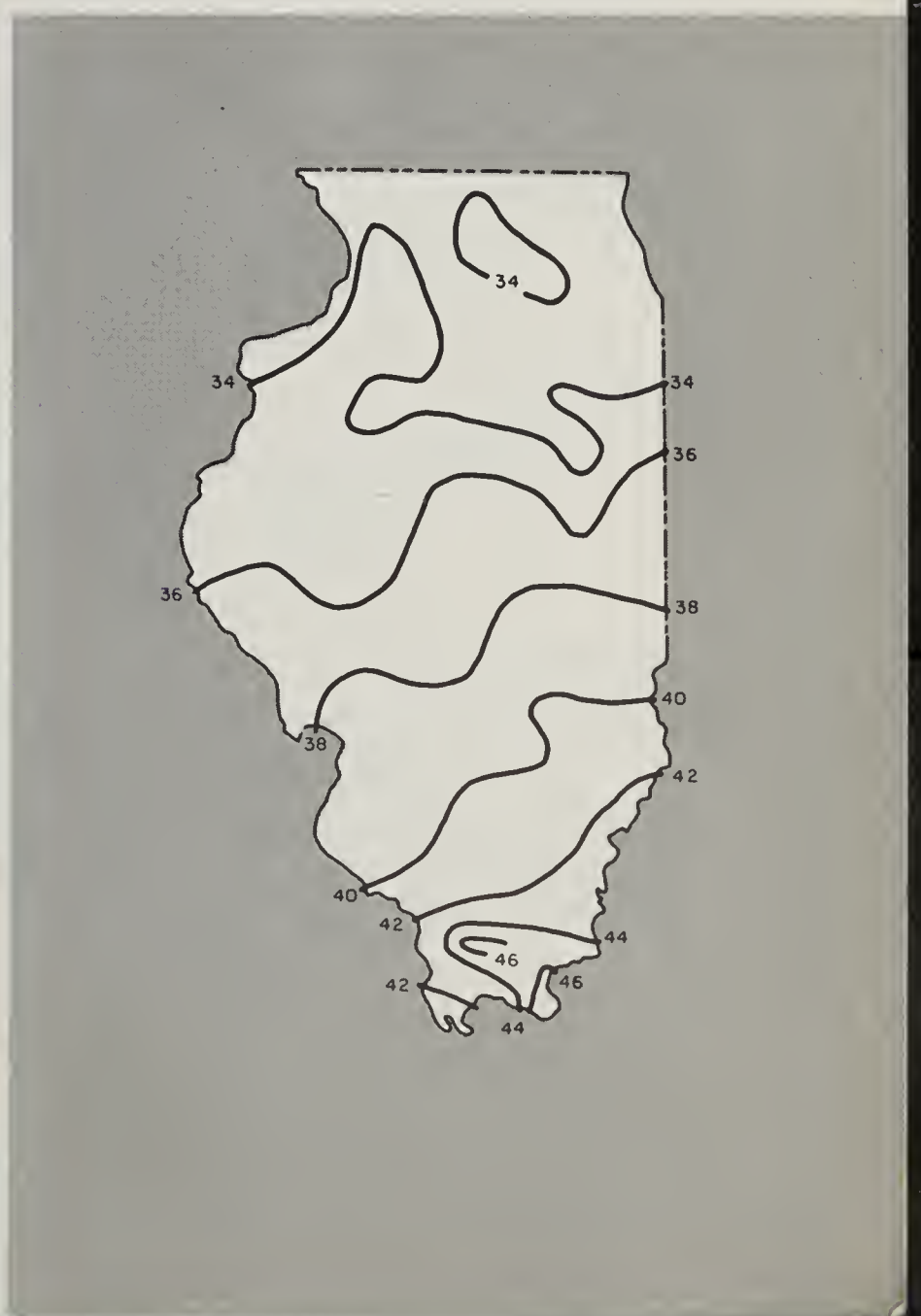


Figure 2. Average annual precipitation in inches.



pheric moisture reaching Illinois travels northward along the Mississippi River Valley and turns eastward along the Ohio River. Ninety-five per cent of this moisture passes beyond the state and only five per cent, or about 99 billion gallons, falls to the land surface in Illinois on the average day. The arrival of atmospheric moisture at the land surface is, of course, quite variable in both time and space. The average annual precipitation in part of southern Illinois exceeds 46 inches per year, while that in northern Illinois is as low as 34 inches per year. About two-thirds of the precipitation in the state occurs during the growing season, April to October, most of it occurring as thundershowers.

Nearly all of the water that is beneficially used by man falls as rain or snow upon the earth's surface. Some of this water soaks into the soil and rocks of the earth's crust and some of it runs off in streams. The water in streams and in lakes is called *surface water* and that which soaks into the soil and rocks is *subsurface water*. Scientists commonly recognize two large classes of subsurface water; these include:

1. Water stored in or moving through the surficial materials of the earth above the top of the saturated zone, commonly called *soil moisture*.
2. Water stored in or moving through the satu-

rated zone beneath the water table, which is called *groundwater*.

Surface and subsurface water account for only about 24 per cent of the precipitation on the land surface in Illinois. The remainder of the water returns to the atmosphere either through evaporation from land or water surfaces (43 per cent) or through transpiration by vegetation (33 per cent).

The transfer of water from the clouds as precipitation to and through the ground to rivers, lakes and the sea and its return to the clouds again by evaporation and transpiration is called the *hydrologic cycle*. The important features of this cycle are shown in Figure 1.

### Subsurface Water

**Soil Moisture Reservoir.** The greatest amount of water that is used by man is withdrawn by plants from the soil moisture reservoir. This is especially true in Illinois where nearly all agricultural activity is dependent upon this source of water supply. The over-all quantity of soil moisture available is directly dependent upon the amount, frequency and intensity of precipitation, the absorptive and retentive abilities of the soil and subsoil, and the nature and number of plants growing in the soil. Precipitation recharges the soil moisture

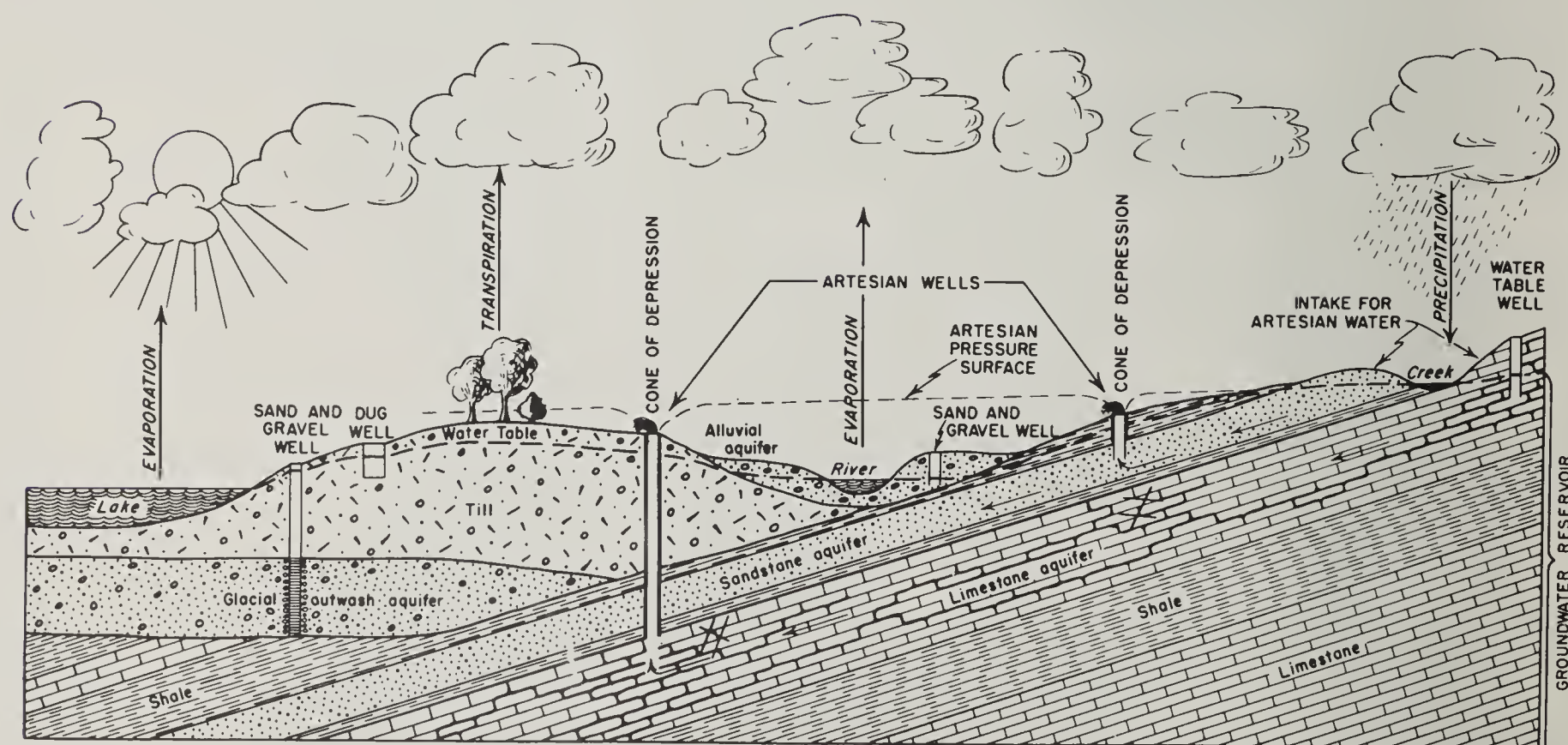


Figure 3. Source, movement and occurrence of groundwater.

reservoir and vegetation discharges water from the reservoir by transpiration.

Some soils are very permeable and water passes easily and rapidly through them. Other soils, usually the less permeable ones, tend to store large quantities of water. Thus, the relative amounts of water retained in, released to, or rejected from the soil moisture reservoir chiefly depend upon the nature and distribution of soil and rock material in the shallow parts of the earth's crust. Level areas and gentle slopes and well-vegetated land favor the entrance and retention of water. Less water infiltrates into the soil moisture reservoir and less available water remains in storage where there are steep slopes and where tight soils and rocks are bare of vegetation.

The inter-relationship of water and soil resources is striking. The soil plays a particularly important role in the water cycle because it is here that water can be stored for use by vegetation or for gradual release to springs and rivers, chiefly through the groundwater reservoir. Even more important, water must infiltrate through the soil into the groundwater reservoir. Good soil provides a favorable environment for plant growth which is also valuable as a storehouse and a retainer of water. The topsoil and the soil moisture reservoir form an important factor in the control of surface runoff.

The amount of pore space and the presence of rotted plant material in soil largely determine the amount of water it will absorb and hold. The slow process of decay of plant life over a period of years causes the soil to assume a crumbly, loose structure capable of holding greater amounts of water and allowing the water to filter slowly through it.

Much water and topsoil can be saved by proper use of land and employing soil and water conservation practices such as fertilizing, terracing, contour farming, strip cropping, reforestation, irrigation, gully control and construction of farm ponds and grass waterways.

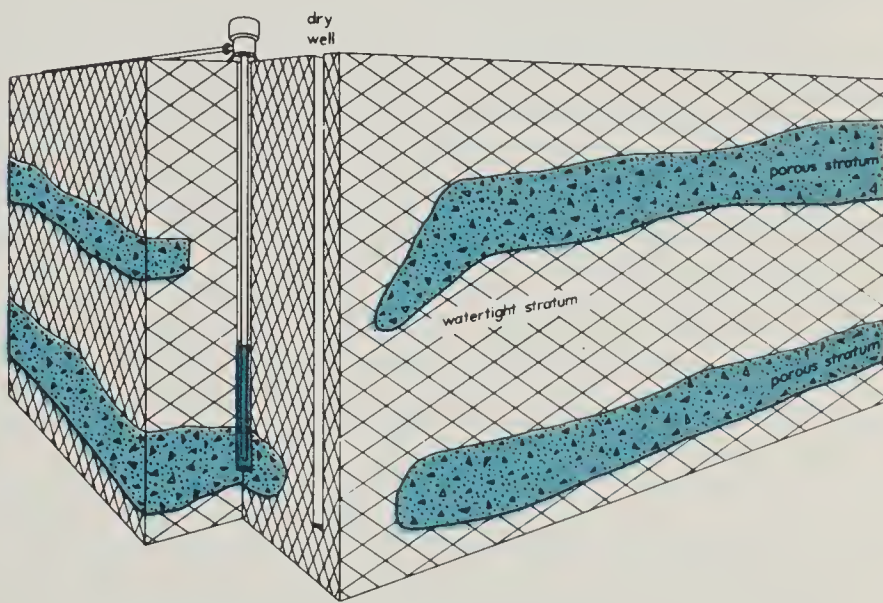
Conservation measures will often help to control the water table, reduce flood peaks and increase the dry weather flow of streams where soil conditions are conducive to deep percolation. It has been said that the best way to control water is by stopping the raindrop where it falls.

**Groundwater Reservoir.** About 14 per cent of the

total precipitation percolates through the soil moisture zone or otherwise reaches the groundwater reservoir. The groundwater reservoir is that part of the earth's crust where all openings within the rocks—from small pores to caverns—are filled with water. The top of this saturated zone is called the *water table*. This reservoir stores large quantities of water, and overflow from it maintains surface streams and lakes during dry weather.

Despite this abundance, there are some areas in Illinois where it is difficult to obtain even small supplies of groundwater because groundwater is not everywhere available for withdrawal by wells. Many earth materials are water-bearing but are impermeable and are therefore not water-yielding.

An impermeable bed such as the till (pebbly clay and silt) shown in Figure 3 may contain a relatively large amount of water per cubic foot but holds the water so tightly that a well drilled into it may be "dry." On the other hand, a bed of sand and gravel such as the glacial outwash shown in Figure 3 may contain much less water per cubic foot than the till, but the water in the gravel is not held and can move readily



**Figure 4.** Groundwater usually travels in permeable strata separated by water-tight layers. Direction, shape and extent of porous strata can't be anticipated accurately so it is possible to drill a dry well right next to an active one. Underground water may travel for miles before it reaches the point at which it is tapped; 50 miles is not unusual. For large supplies, stratum tapped must have a large cross section because of low natural flow rates.

between the grains and into a well. As the well is pumped, more water flows in.

The problem involved in obtaining a satisfactory groundwater supply therefore is to strike a water-saturated "formation" that will transmit its water to the well. Most wells that yield no water are unsuccessful not because of lack of water in the earth, but because a water-yielding formation (an *aquifer*) is not present.

Figure 5 shows a generalized cross section of the underground materials in Illinois roughly west to east from Rock Island through Peru to Chicago. This cross-sectional diagram shows the major strata that enter into the water supply picture in Illinois. It will be seen that these beds are neither level nor uniform in thickness and occurrence. Figure 6 shows the geographic distribution of the bedrock formation underlying the glacial deposits. Figure 7 shows the distribution of water-bearing sand and gravel above the bedrock.

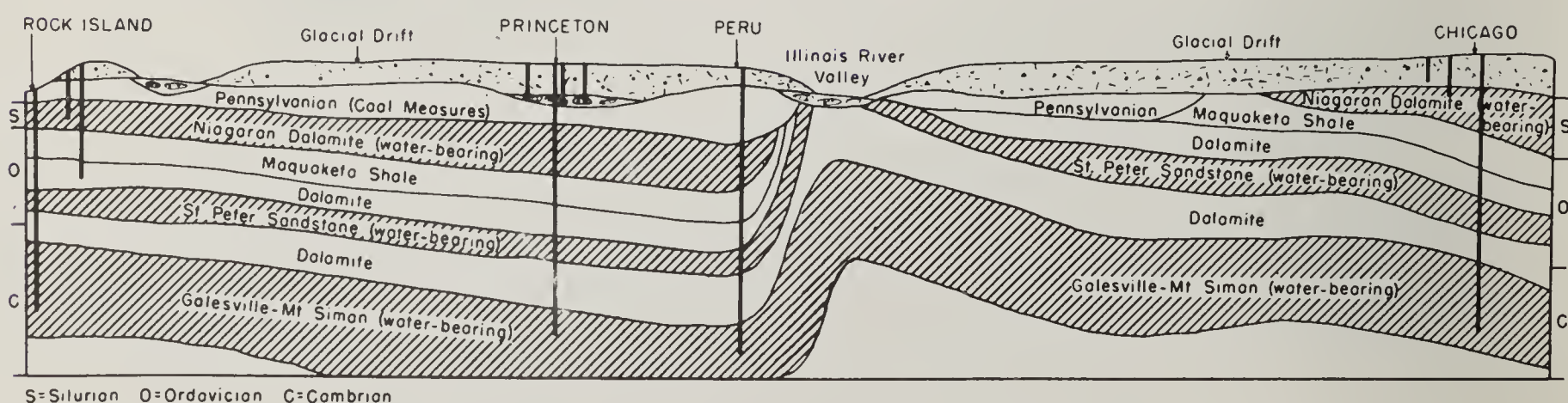
The deepest beds shown in Figure 5 are the Galesville-Mt. Simon sandstone formations. These include thick sandstone layers that yield water freely; wells tapping them are generally from 1,000 to 2,600 feet deep. Above these older water-bearing formations are thick dolomite formations that are less important as a source of water supply. Atop these dolomites lies the St. Peter sandstone, which may be seen exposed at Starved Rock. It is not as productive as the deeper sandstones. Above the St. Peter sandstone are more dolomite and shale layers, some of which yield moderate quantities of water. The Niagaran dolomite lies above these formations and, when not overlain by other bedrock, is a common source of groundwater in a large part of northern Illinois. Throughout much of the state the uppermost bedrock is the Pennsylvanian "Coal Measures" which contains coal, sandstone, limestone and shale strata. In some areas the Pennsylvanian sandstones yield small quantities of water to drilled wells.

In general, throughout the northern portion of the state, wells obtaining water from bedrock formations may have yields of up to 200 to 1,500 gallons per minute. In the northern and western quarter of the zone underlain by the Pennsylvanian rocks some water is obtained from bedrock formations below the Pennsylvanian. Farther to the south in Illinois, water wells penetrating below the Pennsylvanian formations are uncommon because of unsatisfactory water quality.

Groundwater is also present in large quantities in the unconsolidated material which lies on top of the bedrock. Its availability is tied closely to the geologic events which have largely shaped our present landscape.

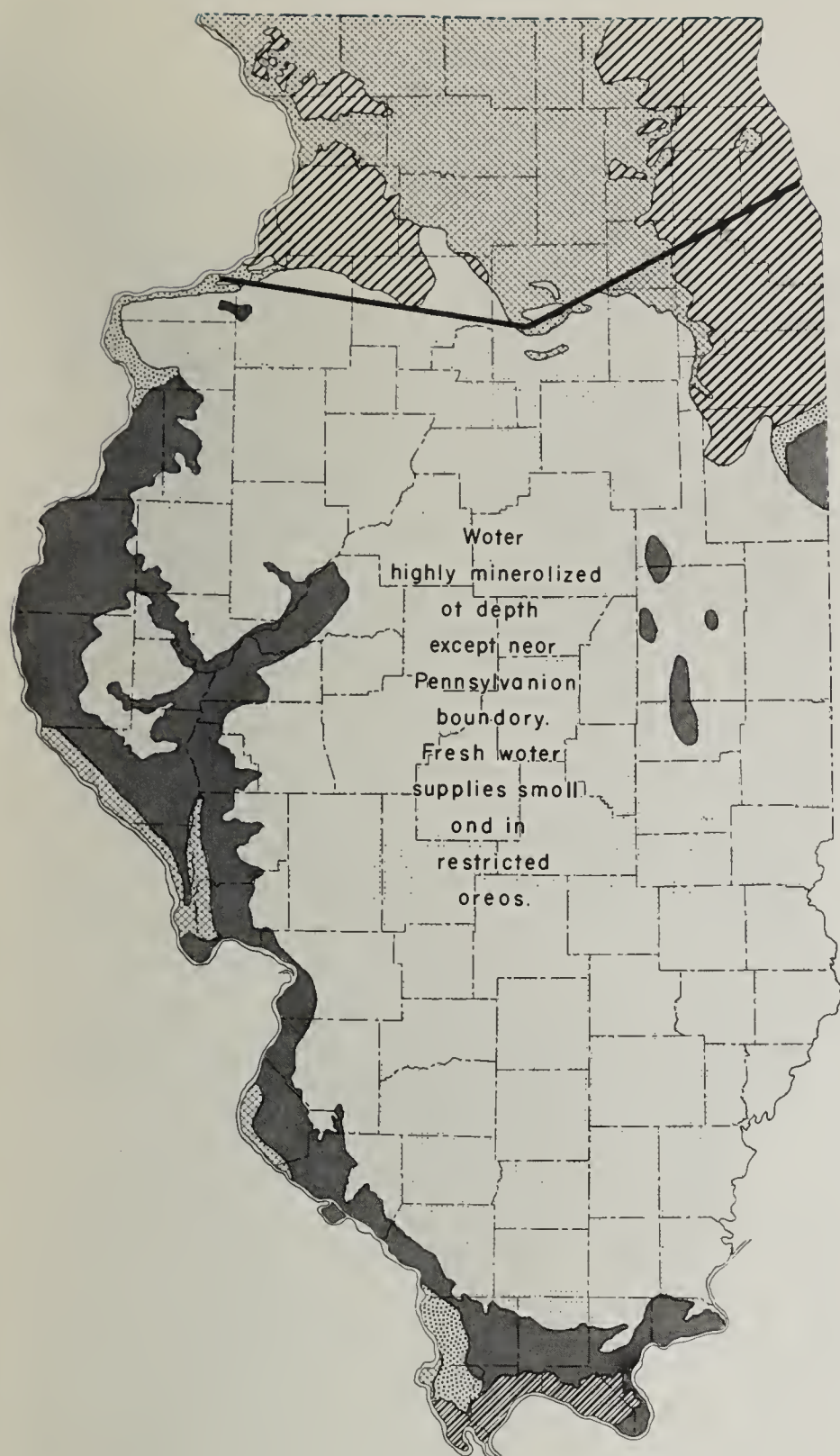
Ancient streams eroded deep valleys into the bedrock surface of the state, many of which are shown in Figure 7. This period of river erosion was followed by several periods of glacial invasion. One of the most important of the glacial periods occurred about 200,000 years ago and is called the Illinoian. This ice sheet covered the entire state with the general exception of those areas not shaded in Figure 7. Subsequently, part of the region glaciated by the Illinoian was overridden by another ice sheet, the Wisconsin, which melted back 12,000 to 14,000 years ago. The area this ice sheet covered is shown by the darkest shading in Figure 7.

The unconsolidated material that overlies the bedrock over most of the state was deposited by the ice and by streams that were present before, during and after the glacial invasion. These materials consist of glacial till, silt and clay, and sand and gravel. The sands and gravels which are free of fine materials are permeable and yield water to properly constructed wells. The thickest and most productive sands and gravels occur in the deeper bedrock valleys, some of which were cut into the bedrock as deep as several hundred feet and as wide as 20 miles. In general, the availability of groundwater in the unconsolidated materials depends



**Figure 5.** Generalized cross section of major underground strata from Rock Island to Chicago. The line of the section is indicated on the following illustration, Figure 6.

## WATER-BEARING BEDROCK



**Figure 6.** This map shows the distribution of various types of water-bearing bedrock under the glacial deposits.

- Cretaceous-Tertiary
- Pennsylvanian and older
- Mississippian and older
- Devonian and older
- Silurian and older
- Ordovician and older

SCALE OF MILES

105 0 10 20 30 40

## WATER-BEARING SAND AND GRAVEL



**Figure 7.**

### BEDROCK VALLEYS

Water-bearing sand and gravel generally abundant

1. Present valleys cut and partly filled by earlier streams
2. Buried valleys

### OTHER GLACIAL DRIFT AND ALLUVIAL DEPOSITS

Water-bearing sand and gravel:

3. Common
4. Thin and discontinuous
5. Generally absent, except locally in lowlands
- Bedrock, no sand and gravel

chiefly upon the number, presence, thickness and lateral extent of the sand and gravel deposits.

On the basis of occurrence of water-bearing sand and gravel, Illinois may be divided into five general regions: (Numbers on Figure 7 correspond to those beside the following categories.)

1. Present valleys likely to contain water-bearing sands and gravels.
2. Ancient bedrock valleys, not discernible from the present topography, which commonly contain water-bearing sands and gravels.
3. Main area of Wisconsin glaciation, in which water-bearing sand and gravel deposits commonly occur.
4. Area of mainly Illinoian glacial deposits, in which water-bearing sands and gravels are less productive and more widely scattered.
5. An area of thin glacial deposits, in which water-bearing sands and gravels are generally absent.

The northern part of the state, excluding the Chicago area, relies principally on groundwater for sources of supply, while much of southern Illinois depends on surface water. In the southern half of the state surface water storage reservoirs are common for the impoundment of water.

As a result of the variety of geologic conditions in Illinois, there are marked differences in the behavior of water passing through the hydrologic cycle. In those parts of the state in which water-bearing formations are widely distributed and permeable, groundwater may contribute as much as two-thirds of the total streamflow. Under these circumstances, dry weather flow is maintained at a relatively high level. In areas where groundwater-bearing materials are scarce and of low permeability, groundwater contributes less to streamflow. Therefore, the streams may flood quickly and then rapidly dry up after storms. In some instances of this type as little as seven per cent of the streamflow comes through the ground.

The recharge of groundwater reservoirs is a very slow process. It is slower in the case of deep water-bearing formation such as those that yield water to the deep wells in the Chicago region than it is where the formations are shallow and not overlain by water-tight materials, which is the case at Peoria and East St. Louis. Partial recharge may naturally occur in a few months in

the shallow formations. In deep formations, such as the sandstones beneath the Chicago area, it may take decades or even centuries for precipitation to reach aquifers over a thousand feet below the surface because this recharge comes largely from lateral inflow entering the strata many miles away. However, partial recovery of lowered water levels in wells in these formations will take place in a few weeks or months if all withdrawals were to cease abruptly. It is believed that only small amounts of water for recharge are locally available from adjacent formations in this instance. In other areas, recovery will result from increased recharge. Therefore, fluctuations of the water levels reflect variations in both recharge and discharge from groundwater reservoirs.

Lowering of water levels is a necessary factor in pumping groundwater. This decline results in movement of water into the well. Withdrawal of larger amounts of water requires increased lowering of water levels. When a well is pumped at a rate less than the maximum rate of yield of the formation, the water levels adjacent to the well will effectively stabilize. If wells are drilled too closely together, each one competes for the same water. Under this condition each well being pumped causes additional lowering of the water level in the others. This is commonly called *well interference*.

From the above discussion it is plain that decline of groundwater levels is not necessarily abnormal or permanently harmful. However, continued decline at accelerating rates increases the cost of pumping water and may indicate that the withdrawal exceeds the amount of water available to the reservoir. This ultimately will lead to temporary exhaustion of the supply. Further, it is clear that groundwater supplies are a renewable resource. Conservation practices, such as proper well spacing, artificial recharge, limiting pumping and natural discharge and other activities promoting the beneficial use of water, can be effectively adopted when necessary data are available.

### Surface Water

Far more is known about the storage, movement and utilization of surface water than is known about soil moisture or groundwater. Also, considerably more surface water is used in Illinois than groundwater.

Surface water represents the surplus water that either could not enter into or that flowed out of the soil moisture and groundwater reservoirs. Therefore, the quantity, occurrence and movement of water between the

three reservoirs is closely related. For example, of the total runoff in Illinois, approximately one-half is derived from discharging groundwater reservoirs. This includes the "base" or low flow of Illinois streams during dry periods plus some increased discharge during or after wet periods when the water table is high.

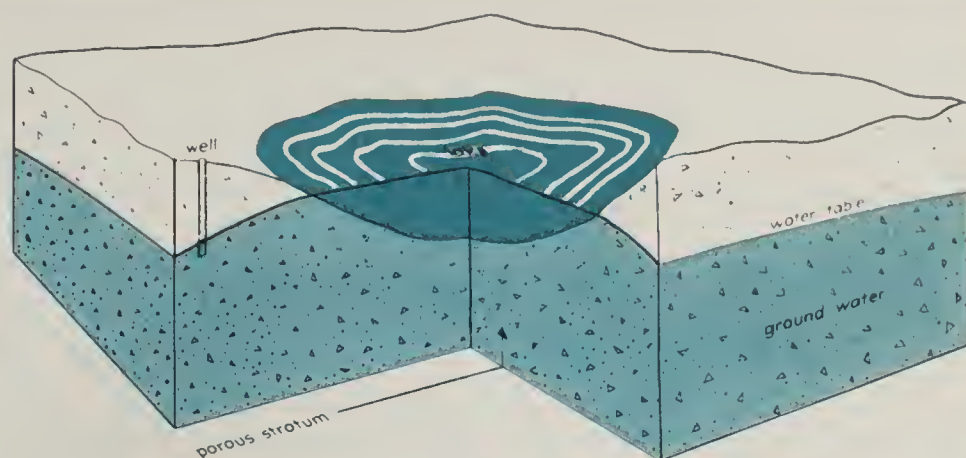
The character of occurrence of surface water strongly influences the development of water supplies from this source. Many factors are involved. Rivers and lakes are open and therefore subject to seepage, evaporation, contamination or pollution, and considerable temperature change. Further, flow of streams is usually rapid enough to erode and to transport undesirable matter, such as sediment and organic material. Because about one-half of the annual runoff depends on direct precipitation, the flow fluctuates widely, with rainfall often resulting in floods and their attendant damage. Except in the larger streams expensive storage facilities are often necessary to insure an adequate source of supply. Consideration of all of these factors must be given in any surface water development.

Illinois is one of the leading states in available surface water. The state has 945 miles of its 1,240 miles of borders bounded by water. These bodies of water include the Mississippi, Ohio and Wabash Rivers and Lake Michigan. More than 500 streams provide drainage and water supplies to the interior of the state. Among the more important of these are the Illinois, Rock, Fox, Kaskaskia and Sangamon Rivers. The Illinois River, exclusive of inflow from Lake Michigan, alone drains about 28,000 square miles of the northeast and central part of the state. More than 23 billion gallons of water a day are carried off by interior streams into the three rivers on its borders. Lake Michigan provides the municipal water and much of the water for industrial needs for about one-half of the state's population in the Chicago area.

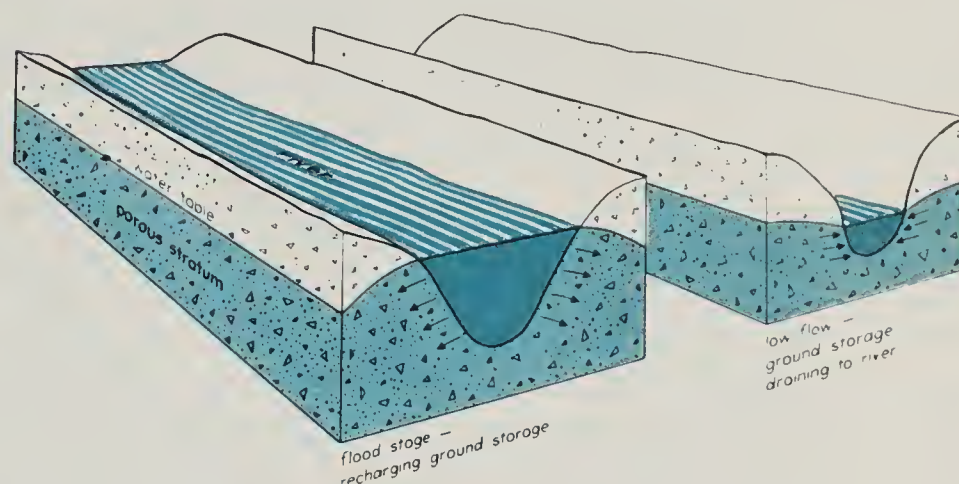
There are approximately 500 lakes and reservoirs and about 600 additional possible sites for reservoirs suitable for municipal water supplies in Illinois. Many other sites for smaller industrial and farm ponds and recreational lakes are also available.

### WHO ARE THE MAJOR WATER USERS?

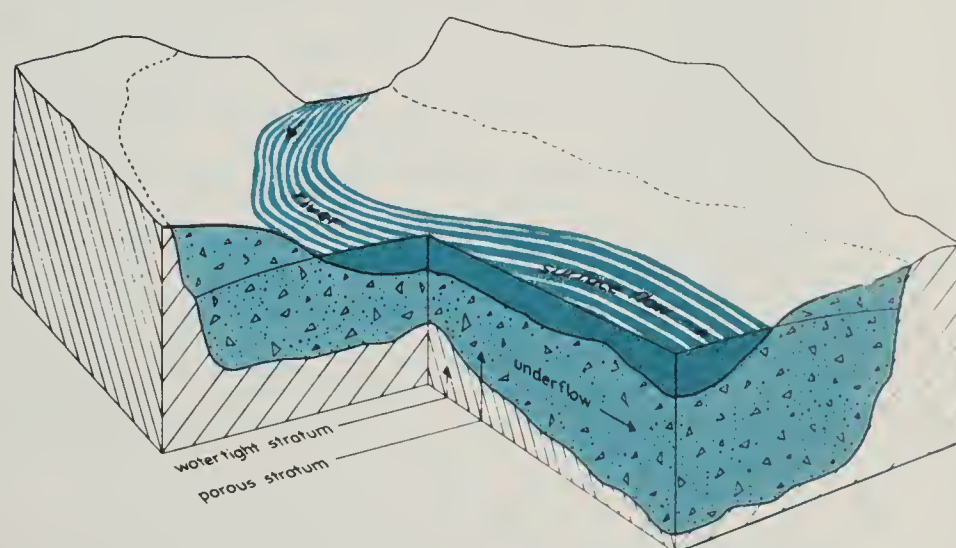
Major uses of water are for municipal, industrial, agricultural, recreational, hydroelectric power generation and navigational purposes.



**Figure 8.** A. The level of underground water is called the water table. It is affected by many factors: rainfall, soil porosity and formations, rate of water removal by pumping are most important. The water table always meets a free water surface, sloping to it or away from it depending on the topography. To tap underground water, wells must be driven below the water table, which fixes height to which water will rise in well. Yield is greatest when well penetrates to bottom of water-bearing stratum.



B. During flood flows, rivers recharge underground water storage, raising the water table in surrounding porous strata. Conversely, when flow falls off greatly and river level drops, groundwater seeps back into river, helps to maintain meager flow. Thus underground storage acts like a flywheel, absorbing some of excess flood water and giving it back during dry periods. Flood flows also help the absorbing action of river bottom by scouring it free of the silt that settles out during low flows, plugs "pores" of bottom.



C. In many cases, the river you see forms only one part of a complete water course. Below the surface river is a "ghost" stream flowing slowly through the porous deposits forming the river bed. This porous material may have been laid down by ice-age glaciers or by the river itself as it wore down mountains during past geological ages. Often the porous material fills a valley formed by water-tight rock. The underflow travels only a few feet per day while the visible river races on for miles. Yet the mass of water stored in the underflow is usually much larger than in the surface river.

Consumed water is that water which is lost for readily practical re-use. It includes all evaporated and transpired water and water that is incorporated into the end product in industrial, agricultural and other processes. Most of the water utilized in industry, municipal supply and recreational projects is not consumed and is available for re-use, whereas consumptive use in agriculture is high.

### Municipal Use

Municipal use of water consists of that which is taken from ground or surface sources, treated and supplied to users by publicly or privately owned water companies. Included in this category is that water needed for commercial and household use and for such public services as fire fighting and street washing.

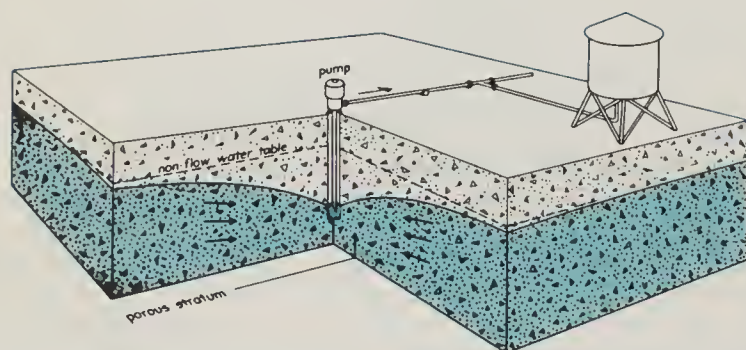
Forty per cent or more of the municipally processed water of a community may be used by industry. For example, industry in the greater East St. Louis and Granite City area uses about 51 per cent of the total water delivery of the water company serving the area. Household and commercial use has increased considerably during recent years due to expanded population and greater per capita demand brought about by widespread installation of such modern conveniences as air conditioning equipment, automatic washing machines, dishwashers and indoor plumbing. It has been estimated that air conditioning equipment in Chicago increases

water demand by 250 million gallons on a warm summer day. There also has been an increasing proportion of the residences connected to municipal systems which were not previously served by this source. In some communities the proportion of residents served by public systems has increased from about 25 per cent to nearly 100 per cent during the past 25 years.

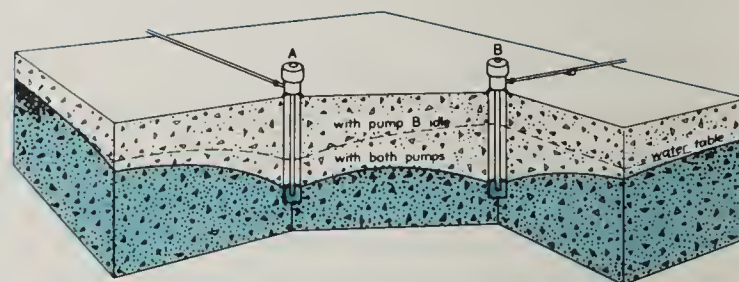
Recent estimates indicate that about 1,371 million gallons of water are distributed by Illinois municipalities daily. Of this, Chicago and connected suburbs account for 1,029 million gallons, all of which is pumped from Lake Michigan. The remainder includes 179 million gallons from surface water sources and 163 million gallons from underground sources. The average daily per capita pumpage is 250 gallons in Chicago and connected suburbs and 120 gallons in the balance of the state. The average daily per capita pumpage for the state is 197 gallons. About seven million people, 80 per cent of the state's population, are served by public water systems.

### Industrial Use

Industries in Illinois utilize more than eight billion gallons of water daily for cooling, electric power generation, processing, sanitary services, fire protection and other purposes. Manufacturing and other industrial processes generally require larger quantities of water than any of the other raw materials used. (See Table 1.)



**Figure 9. A.** When a pump draws water from a well, level in the well drops, and water flows "downhill" from the surrounding ground. How fast it flows depends on the permeability of the water-bearing stratum and on the "head" between normal water table and the lowered level in the well. When rate of seepage into well balances rate of withdrawal, water level becomes constant. Result is a conical dip in water table around the well, called the cone of depression. If well is pumped faster, cone becomes deeper. Too fast a rate cuts yield.



**B.** With two wells next to each other, double cone of depression appears when both operate. Doubling the number of wells does not necessarily double the capacity. Because of limited rate at which underground water can flow, increasing the rate of pumping in a given area simply lowers the water table. This means deeper wells, higher lifts, and hence greater pumping costs. In the long run, amount of water withdrawn from an underground area cannot exceed what comes into it by underground flow from its charging area.

Water needs per unit of product vary considerably from plant to plant due to variations in many factors including techniques, efficiency and degree of conservation employed. The main industrial users of water in Illinois are the steam power generation, steel, petroleum, chemical and distilling industries.

The sources of this water for industry are municipal mains and private wells and intakes drawing directly from rivers, canals and lakes. Excluding water supplied by municipalities and water required by power plants employing steam generating equipment, about seven-eighths of the industrial water comes from surface sources and the remainder from groundwater sources.

Three important criteria for a suitable industrial water supply are the following:

1. An adequate supply for present and expected future demands.
2. Satisfactory quality for the purpose it is to be used.
3. Economical to procure and treat.

The degree of relative importance of each criterion will vary considerably from industry to industry and even from factory to factory.

Some industries have expended considerable effort and money to secure adequate water supplies. As an example, early in 1956 the Granite City Steel Company announced the building of a reservoir, a pumping station and an underground pipeline four miles long to supply water needed as a result of an addition to the firm's steel producing capacity. The new facilities will be able to provide the plant with 25 to 35 million gallons of water a day to be used for cooling processes.

Table 1. Industrial Water Requirements

Industry	Unit	Water Required Gals. per Unit
Gasoline	1 Gal.	7-10
Canning Vegetables	Case No. 2 cans	25-35
Electric Power	Kw. Hr.	80
Packing House	Cattle (per animal)	2200
Coke	Per ton	3600
Finished Steel	Per ton	65,000
Synthetic Rubber	Per ton	600,000

In 1950, the President's Materials Policy Commission (Paley Commission) forecast an estimated 170 per cent increase in industrial water use by 1975. Some recent estimates place the expected increase in the next twenty years alone at 200 per cent. As indicated previously, much of the water used by industry is actually only "borrowed" from its source and eventually is returned to lakes or streams after it has served its purpose. The temperature and quality of this water may be changed considerably, however. Water from wells, of course, is usually not returned to its original source. The use of water for steam power plant and cooling purposes in industry (proportionally large uses) affects only its temperature and this water may be readily used again.

### Agricultural Use

Agriculture is the largest single user of water in Illinois. Its use is greater than that of all other users combined. Thirty-three billion gallons daily are withdrawn from the soil moisture reservoir, most of which probably is returned to the atmosphere by transpiration through vegetation. Water is a basic requirement of this two billion dollar segment of Illinois business. An estimated thirty thousand pounds of water are needed to produce a bushel of wheat and equally large quantities of water are needed for other farm products. Farmers are increasing their consumption of water as they continue to strive for higher yields.

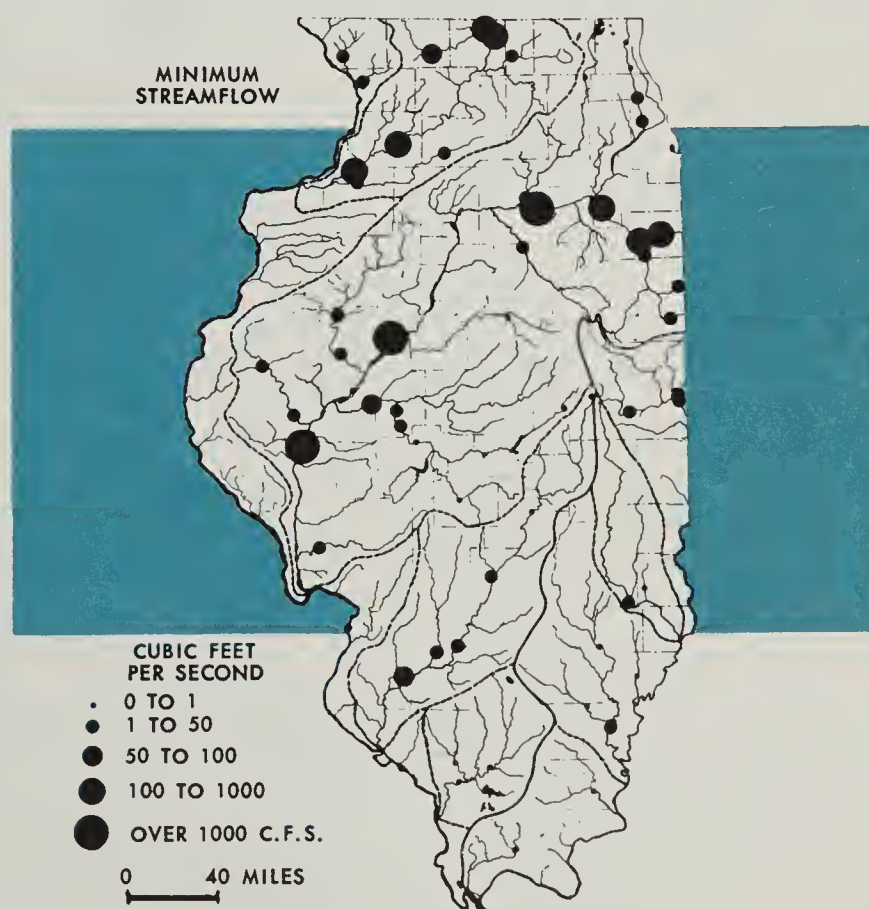


Figure 10. The minimum flow of streams and rivers in Illinois. The broken lines indicate the drainage areas of major state river systems. The solid line in the southeastern quarter of the state represents the drainage divide between the Mississippi River and Ohio River watersheds.

Some water from wells, streams and ponds is used on farms for irrigation and livestock consumption. Total usage of water on farms for irrigation, livestock and other farmstead purposes is about 132 million gallons per day. Rural uses, exclusive of that used on farms, account for about 50 million gallons daily.

By source, 33 billion gallons of water a day for agricultural use come from the soil moisture reservoir, 170 million from the groundwater reservoir, and 12 million from the surface water reservoir.

Only high-value crops are irrigated in Illinois. Irrigation is used principally in this state to provide insurance against short-term lack of water, but optimum yields of a number of crops require supplementary irrigation. Huge amounts of water are needed for irrigation; thus it follows that large supplies are an essential to any farmer engaging in this practice. For example, 27,154 gallons of water are needed to put one inch of water on an acre of land. Estimates made in 1954 indicate that in that year only approximately 14,000 of the 36

million acres of cropland in the state were irrigated. Recent experience in other states indicates that a great increase in this practice may be in prospect.

### Other Uses

The use of Illinois water resources for recreation, navigation and hydroelectric power generation is significant but does not result in water consumption or changes in the quality or quantity available to other users. Because of space limitations in this report, these important uses and attendant problems cannot be treated in detail. The following brief statements will serve to give some indication of the benefits derived from the use of the state's water resources for these purposes.

Clean streams, lakes and rivers scattered throughout the state provide excellent recreation facilities which will be needed to a larger and larger extent by our growing population. Lake Michigan alone is enjoyed by millions of fishermen, boating enthusiasts, swimmers and sunbathers each year.

## Water-use picture seems simple but isn't

In the strict sense, water is never lost. No matter what we do with it, water finds its way back into the natural cycle. It might thus be argued that it makes no difference what water is used for, or how it is used. Actually, what happens to the water is a matter of extreme importance because various uses "borrow" water from the natural cycle for longer or shorter periods and because there are often significant differences in how and where the water is "returned." These differences may be enough to upset local supplies. The drawing, right, pictures typical uses and their differences.

To start with, many uses involve little or no disturbance of nature's cycle. Water in the lake and stream pictured goes its way unaffected by the sailing and swimming of recreation seekers, or by the passage of craft navigating its lower reaches. Natural water supplies like these breed fish and support waterfowl and other forms of wild life. And we mustn't forget that most of our farms depend on rainfall and hence "use" water without taking it from the natural cycle.

Many uses represent only the most trifling borrowings and do not significantly affect the immediately available water resources of the region. Water merely passes through

turbines of the hydro plant and condensers of the steam power plant. Hydro use changes only potential energy. Condenser use, like many industrial cooling processes, changes only temperature.

Apt to be critical are the uses that reduce the water immediately available to the region. Much of irrigation water, for example, goes back to the atmosphere by evaporation and transpiration. It may, or may not, return to the region as rainfall. Thus the farmer using well water for sprinklers may cause a net reduction in the region's groundwater supplies. The factory owner who installs a recharge well returns much of his withdrawal to essentially the same place in the cycle and at nearly the same time.

The state in which the water is returned also makes a big difference. Our municipal system draws water from the stream and the sewer system discharges back into it. If these wastes, and those of the industries using the stream, are treated, there's little net change in the region's available water. But if wastes aren't treated the entire downstream flow may become badly polluted and its usefulness diminished or even completely lost. This reduces the region's supplies.

Figure 11.



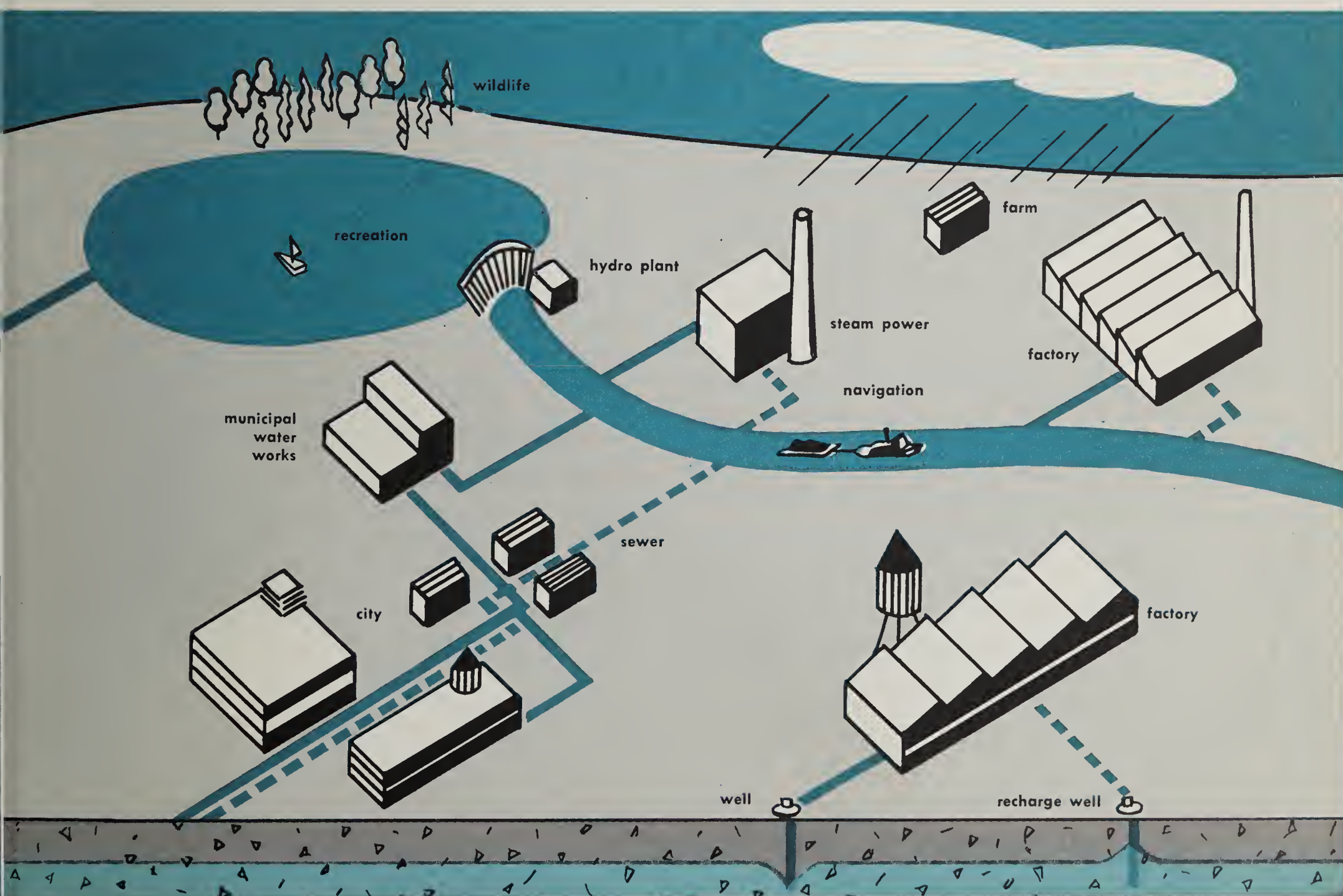
Illinois has 1,147 miles of navigable waterways within and on its borders. In 1953 approximately 20 million tons of cargo were transported on the Illinois Waterway alone. Chicago already is a great inland port and will become an even greater one upon completion of the St. Lawrence Seaway, the improvements being made in the Calumet-Sag Canal and the development of the Lake Calumet Harbor.

A recent survey indicated that the eleven hydroelectric stations in Illinois and the two on its borders have an average annual output of 911.3 million kilowatt hours (crediting Illinois for one-half of the output of the plants on its borders). Hydroelectric power generation demands an additional 21 billion gallons of water a day not included in any other estimates given in this report.

### ILLINOIS WATER PROBLEMS

As is indicated in the foregoing sections, the three water reservoirs are closely related and proper develop-

ment and conservation practices involve close consideration of this relationship. Early development of water supplies often overlooked this now well-known relationship, but needs usually were small and easily satisfied. With the increasing demands on our water resources we have come to recognize more and more that we cannot ignore this delicate natural balance. Further, we now recognize that we must make plans to meet our water supply requirements far in advance of the time when they are actually needed. Frequently, a water problem suffered by a specific user class or area is actually a combination of several problems. For instance, in parts of southern Illinois where groundwater resources are scarce, pollution of ground and surface water by industry and municipalities and reservoir sedimentation damage due to failure of farmers to practice conservation added to the natural problems of drought during 1952-1955. It is readily apparent, then, that water problems may be both varied and complex and solutions to them extremely difficult to effect.



## Erosion and Sedimentation

**Erosion Damage.** Erosion is the process by which water or wind pick up and transport particles of soil and rock. These particles may be deposited a few feet or many miles from their original location. It can be readily seen that this process may cause serious difficulties not only at the point where erosion takes place but also while sediment is carried in the stream and at the point where it is again deposited. The rate of erosion depends on many factors. Among the most important are:

1. Soil and rock type (composition and whether tightly consolidated or unconsolidated).
2. Vegetative cover and amount of organic matter in make-up.
3. Distribution and intensity of precipitation and nature of runoff pattern.
4. Degree of surface slope.

Contrary to popular belief that gully type erosion causes the greatest losses, the large bulk of the soil lost is carried away from relatively flat land in Illinois by sheet erosion. This sheet erosion occurs because soil which is loosened by plowing or laid bare by vegetation removal is more susceptible to the action of water or wind passing over it. On the other hand, soil which has the protective cover of plants and their roots resists the pull of wind and water. Clearing off timber and brush and heavy plantings of such clean-tilled crops as corn and soy beans have increased the opportunity for soil erosion to occur. Experts say that annual soil losses of 50 tons per acre are not uncommon when corn or soy beans are raised on a slope. This lost topsoil was built up at the rate of only about one inch every 500 or 600 years.

It has been estimated that 2,500,000 acres of Illinois land should be taken out of crop and pasture and put into forest land. Authorities on soil erosion indicate that about seven per cent of the total land in Illinois is idle, has been cut with gullies or has been worn out due to 100 years of misuse. Annual erosion damage in Illinois is said to approximate \$70,000,000.

**Sedimentation Damage.** Deposition of the eroded sediment carried off by water also causes many difficulties. The holding capacity of Illinois reservoirs has been greatly reduced by huge deposits of water-borne

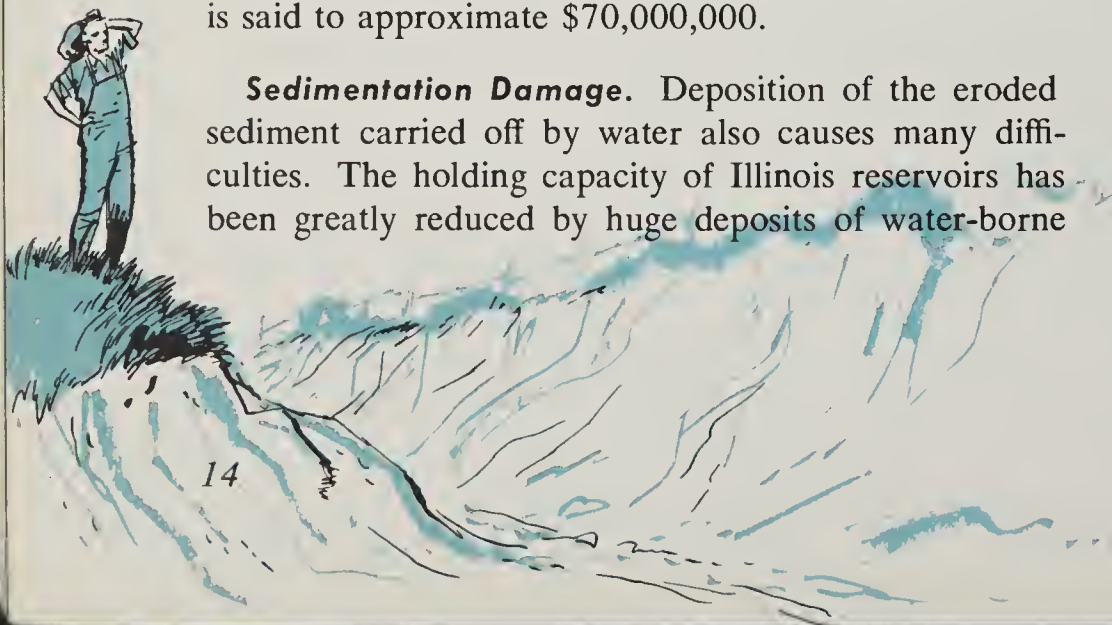
silt. A State Water Survey study indicates that 2.8 tons of sediment per acre of drainage area are being deposited each year in Crab Orchard Lake near Carbondale. This study showed that 50 per cent of the crop land in the drainage basin was planted in corn and other clean-tilled crops. A similar study indicated that the yearly losses in capacity of Lake Springfield, where siltation damage has been held to a minimum, would cost over \$17,000 annually to replace. Table 2 shows the reduction of storage capacity of ten Illinois reservoirs since construction. Studies by the State Water Survey indicate that a yearly reservoir capacity loss of more than 0.25 per cent due to sedimentation should be considered excessive for Illinois. Many farm and private ponds have also become useless because they have rapidly filled with silt, partly due to poor design.

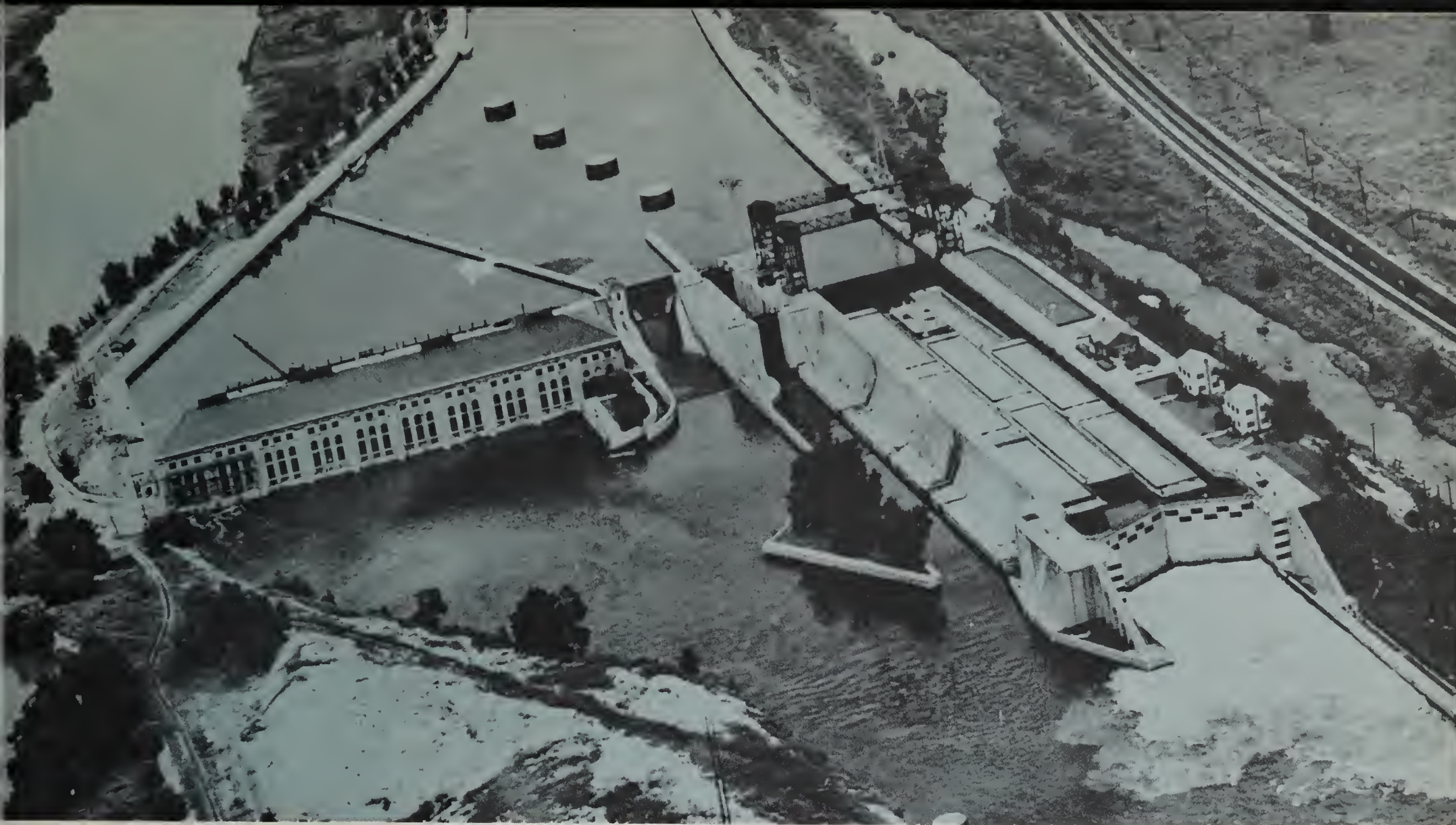
Much of the original silt carried off the land clogs drainage ditches or falls to the bottom of streams and rivers. These silt formations have, in a few cases, reduced the amount of water which can filter into the underground deposits by forming an impervious cover on the stream beds. Sediment deposited on crop land by overflow will kill the existing crop and may seriously damage land permanently.

It has been estimated that 68,000 acre-feet of soil per year are eroded from the Illinois River drainage basin. This soil is deposited in minor watercourses, on low-lying land, in reservoirs and as silt in the Illinois River system.

Deposition of sediment in stream beds results in lowered carrying capacity and causes overflow of banks during floods. When the stream beds are shallowed by deposition, navigation is impaired. Expensive dredging is necessary to keep the channels of proper depth open for river traffic. A striking example of the effects of such sedimentation is provided by the Galena River channel at Galena which was once navigable by steamships to the center of the community. The channel has become so filled with silt that now it seems unbelievable that navigation there was ever possible.

Excess sediment content in streams often makes the water undesirable for industrial and municipal use and, in many instances, necessitates additional treatment to secure water of satisfactory quality. A heavy sediment load destroys aquatic animals on which fish feed and interferes with their propagation by covering spawning beds with sludge deposits.





**Figure 12.** An eight barge tow locking through at Lockport on the Sanitary and Ship Canal. Powerhouse at left is operated by the Chicago Sanitary District and controls water levels between Lockport and Lake Michigan. In addition to its use for transportation and power generation purposes this same water also serves industries, municipalities, farmers and recreation seekers before it flows into the Mississippi River.

**Soil Conservation in Illinois.** Ninety-eight per cent of all farm land in the state is located in soil conservation districts. Only Lake, DuPage and Sangamon Counties are not in organized districts. However, only about 20 per cent of the farmers in the districts are active cooperators and have adopted complete plans for good land use on their farms.

Proper treatment and care of the soil and water resources represents the difference between a substantial profit and a bare existence on a surprisingly large number of farms in Illinois in the long run. Good soil conservation practice benefits the farmer in the form of increased production, lowered unit costs and increased profits. It has been estimated that establishing a thorough conservation program in the Crab Orchard Lake watershed would cost \$38.47 per acre, but the cost would be regained by increased production in only four years.

Among the reasons why many farmers are still not practicing soil and water conservation are the following:

1. Lack of time to devote to needed soil conservation work.

2. Lack of knowledge about good conservation practice.
3. Lack of financing for capital improvements.
4. Landlord is not in favor of investment in soil conservation work.
5. Relatively high prices for some commodities such as corn and soy beans have encouraged growing crops which are counter to the best interests of soil conservation on certain farm land.

Before real progress toward more complete soil and water conservation can be made, these obstacles of the individual farmer must be overcome. Landlord and tenant must realize that profits are being shown at the expense of investment over the long run when soil and water conservation is not practiced.

Until a higher degree of soil conservation practice is attained, erosion and sedimentation damage will continue to be serious.

### Water Shortages

Water shortages may be due to natural or man-made causes or combinations of both. Among the major factors contributing to water shortages which affect all user classes are drought, waste, inadequate water source development, deficient treatment and transmission facilities, excessive pollution of available water and demands in excess of naturally available supplies. The drought of 1952-1955, which was severe in the southern half of Illinois, caused widespread distress due to shortages of public and private water supplies and of soil moisture.

Creeks, farm ponds and small lakes dried up in many areas. Stop-gap measures had to be taken which were extremely costly and generally presented no long-term solution. Farmers hauled water for their stock or sold much of it prematurely when their water supplies on the farm failed. Almost total crop failure resulted in parts of southern and central Illinois.

Many communities found themselves at times during this period with only a few days' supply of water on hand. Use of water for car washing, lawn sprinkling and similar tasks was almost universally restricted in towns in the drought area. Eight communities were forced to haul water in trucks, eight developed supplemental groundwater supplies and 13 laid pipelines to emergency sources of supply.

At one time in 1954, 64 communities were suffering from water shortage. Forty-one downstate counties were declared to be in a state of emergency during the worst part of the drought. A total of 75 communities were affected by water shortage in the drought area in the southern half of Illinois during the three-year period ending March 1, 1955. Of the 75 shortages, 22 occurred in communities using groundwater and 53 in surface-water-using communities. (See Table 3.) While surface water supplies are much more common in southern Illinois than in the northern part of the state,



**Figure 13.** Sediment deposits have reduced the holding capacities of many reservoirs in Illinois.

Table 2. SEDIMENTATION DATA ON  
TEN ILLINOIS MUNICIPAL WATER SUPPLY RESERVOIRS

Surveyed by the Illinois State Water Survey

City Reservoir	Original Capacity (Million Gallons)	Capacity When Surveyed (Million Gallons)	Age When Surveyed (In Years)	Per Cent of Total Original Capacity Lost	Per Cent of Capacity Lost Yearly
Lake Springfield . . . . .	19,959	19,089	14.6	4.36	0.30
West Frankfort Reservoir . . .	526	487	22.9	7.55	0.33
DuQuoin Reservoir . . . . .	580	543	18.0	6.30	0.35
Lake Gillespie . . . . .	260	226	32.0	12.94	0.40
Crab Orchard Lake . . . . .	23,054	21,938	11.2	4.85	0.43
Eldorado Reservoir . . . . .	258	222	29.0	14.00	0.48
Carbondale Reservoir . . . .	453	390	22.1	13.90	0.63
Lake Carthage . . . . .	133	101	23.4	24.10	1.03
Lake Decatur . . . . .	6,454	4,763	24.2	26.20	1.08
Carlinville Reservoir . . . . .	562	465	15.5	14.50	1.11

there are several small groundwater supplies and a few rather sizable supplies in the area. The basic difficulty in that part of the state is the absence of widespread deposits favorable for high capacity well fields yielding good quality water. Fifty-eight per cent of the communities relying on surface water supplies experienced shortages, as compared with only 11 per cent of the groundwater-using communities.

Droughts cannot be prevented or controlled, but their effects can be lessened by adequate soil and water conservation by farmers and by water conservation measures and more appropriate water source development by communities and other users affected. Factors contributing directly to the water shortages during 1952-1955 were reservoir siltation, population increases, declines in capacity of wells and greater household and industrial water use. Far-sighted management of community water supplies could have averted most of the difficulties suffered by localities in the drought area in 1953-1955. The shortages in 32 of the 64 communities affected in September, 1953, were attributed to deficiencies in treatment or distribution facilities. Failure of

cities to take adequate steps to correct their problems may be due to one or more of the following:

1. Inadequate management.
2. Municipal finance problems.
3. High cost of long-term improvement.
4. Lack of understanding or information for proper planning and design of water works.
5. Lack of information on available water resources or understanding about their most efficient use.

Often, high turnover in municipal water department personnel results in a low level of competence. Increased management efficiency would largely avoid the following factors contributing to water shortages:

1. Leaks in water mains.
2. Lack of metering of water.
3. Unauthorized uses of water.
4. Incorrect operation of water works equipment.
5. Poorly planned capital improvements and over-all design.

Long-term management of water systems in some communities has shown lack of imagination, far-sightedness, or even a basic understanding of the problems at hand. Rates have often been too low to maintain and expand proper service. In some instances otherwise adequate revenues are partly diverted into general municipal funds leaving insufficient financing for necessary maintenance and expansion. Development of adequate supplies and provision for central treatment facilities, pumping equipment and mains have not kept pace with increased water needs of older areas and those of newly built-up areas on the fringe of the original community.

The State Water Survey reported that a number of municipal reservoirs failed in 1954 as a result of the imposition of demands of up to six times the amount of water for which the reservoirs were originally designed to provide. These inadequacies were, to a great extent, due to a lack of adequate information at the time of their design and construction. Population growth in some cases was larger than had been planned for.

The Chicago metropolitan area has an almost unlimited supply of surface water available from Lake Michigan, but inadequate storage and transmission facilities have caused frequent pressure failures in suburban communities and parts of Chicago in summer months.

Periodic pressure failures during periods of heavy use are common in many localities. On at least one occasion during the summer months of 1955, water pressures in some suburbs of Chicago dropped from a normal 35 to 40 pounds per square inch to as low as 1½ pounds. Industrial development activities are often hampered by inadequate water facilities. Some fringe areas in a number of communities pay higher fire insurance rates and have inferior fire protection due to the lack or inadequacy of municipal water system facilities.

### Groundwater Supply Difficulties

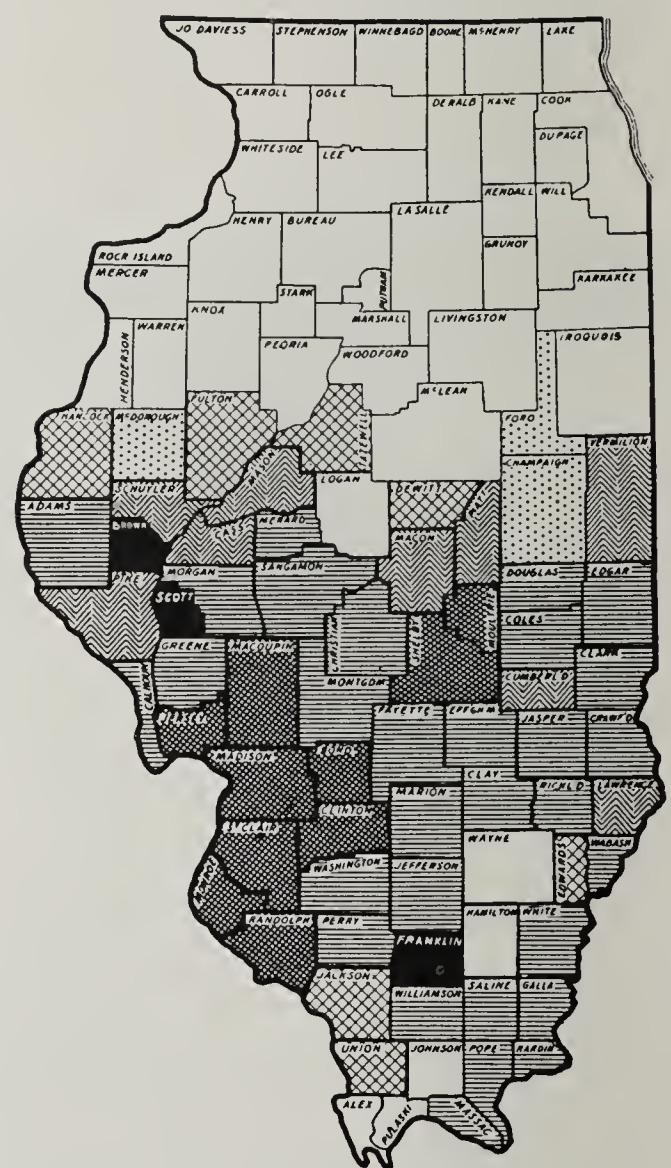
Difficulties with groundwater supplies are complex and fall into three general categories:

1. Problems arising from geological limitations of the water-yielding and adjacent beds.
2. Problems relating to quality of water.
3. Problems resulting from well interference in areas of concentrated withdrawal.

In the first two categories, many formations limited both in extent and permeability and by quality of water

occur in central and southern Illinois. In the third category, several areas of concentrated withdrawal such as Chicago, Peoria and East St. Louis are well known.

**Difficulties Due to Geological Limitation.** Difficulties in widespread deposits result from the effects of pumping by one user on water levels in the wells of other users when the formations being drawn on are of limited permeability and size. In widespread deposits of high capacity, as in northern Illinois, these effects may cause large increases in the cost of pumping of water, but seldom produce absolute shortages. These problems are generally met by setting the pump deeper in the well. In widespread deposits of low productivity serious problems arise. In one small community in southern Illinois, for example, five wells, each of approximately five



**Figure 14.** Degree of drought damage to farm crops —1954.

	Disaster		Moderate to Serious
	Serious to Disaster		Moderate
	Serious		Little to Moderate

gallons per minute capacity, are required to produce the public water supply. Any large use by industry or agriculture in this area would render the existing public water supply inadequate.

In some cases, sand and gravel deposits adjacent to rivers or other bodies of water may receive recharge from them. In some locations this recharge may be substantial, and in others it may be small. These situations require individual study to determine whether increases in groundwater use may induce increased flow from surface water sources into the underground formations.

**Problems Due to Quality of Water.** As is shown in Figure 6, the aquifers underlying that part of Illinois overlain by the Pennsylvanian rocks contain highly mineralized water. The only fresh water aquifers are the sand and gravel deposits and a few relatively tight sandstone layers in the upper part of the Pennsylvanian rocks. Some of the deep-lying aquifers yield water that is used in secondary recovery of oil (water flooding). This is the only use of water from these aquifers at present.

Many other problems regarding water quality exist locally both inside and outside of the area described. For example, water from the limestone underlying the glacial deposits in northeastern Illinois cannot be used for certain industrial purposes. In other places groundwater is subject to contamination by industrial wastes, especially in shallow aquifers.

**Difficulties Due to Concentrated Utilization.** Groundwater problems usually result from heavy concentrations of use of groundwater in small areas. They may sometimes be relieved by spreading out the taking of groundwater over greater areas, where this is practicable. For example, the municipal supplies of Champaign-Urbana were withdrawn from sand and gravel beds for many years. During the nineteen forties, however, industrial and municipal withdrawal from these beds increased considerably. As a result, water levels declined slowly at first and then more rapidly, until a critical situation was believed to exist. Exploration indicated that water-yielding beds were present in a nearby area, new wells were drilled, and the withdrawal on the overpumped aquifer was relieved. A cooperative arrangement between the users has been legalized through the courts to protect each of them, thus eliminating competitive exploration of the aquifer. In other cases of limited formations, well interference due to

**Table 3. CAUSES OF WATER SUPPLY DIFFICULTIES  
MUNICIPAL SUPPLIES IN THE DROUGHT REGION  
1952-1955**

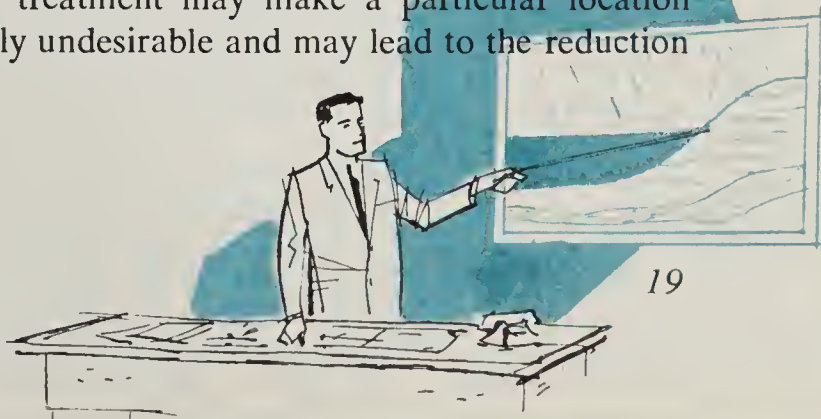
	Surface Water Sources	Ground- water Sources	Total
Capacity insufficient to meet anticipated demands. . .	23	15	38
Decline in capacity. . . . .	4	5	9
Unexpectedly large increase in demand. . . . .	26	2	28
Total . . . . .	53	22	75

heavy pumpage has resulted in the necessity for deeper pump settings and higher power costs.

Over-pumpage, long-term deficiency of rainfall, construction of drainage projects and stream bed siltation are among the causes of lowering of groundwater levels. The seriousness of difficulties caused by lowered groundwater levels can be readily appreciated when the importance of this source of water is assessed. For many purposes in industry, water from underground sources is preferable to surface supplies because of constant temperature, reliability, purity, or other qualities. Groundwater may also be preferred by an industry because it can sometimes be obtained in the necessary quantity within the land holdings of the industry's establishment and no further acquisition or easement of land is required. In some cases these underground water supplies are the only source of water available for all uses.

Three metropolitan areas in Illinois, East St. Louis, Peoria and Chicago, are among the ten areas of the United States in which industrial groundwater development is heaviest. East St. Louis uses the largest amount of industrial groundwater per person per day in the country (736 gallons) and Peoria is second (680 gallons). Difficulties from the lowering of groundwater levels have arisen in recent years in Chicago, Joliet, Rock Island, Peoria and East St. Louis.

The costs of securing groundwater increase greatly as the level of pumping lowers. This water problem is usually economic rather than natural, because the formations still contain water. Industrial development experts point out, however, that this increased cost of supplies or treatment may make a particular location economically undesirable and may lead to the reduction



of industrial payrolls or thwart future industrial development efforts in the area. In many instances the greatly increased cost of pumping groundwater will force industries to stop using this source and turn to municipal supplies or other sources to meet their needs, as they have in the Chicago area. With each reduction in use, the water level rises or the rate of drop is retarded.

The heavy groundwater withdrawal by one user has a definite effect on other nearby users when they are using water from the same underground reservoir. Aquifers do not conform to property lines so withdrawal of groundwater in great quantities by an industry, a municipality or a farmer may in turn increase the cost of obtaining water for other nearby users.

**Well Construction Difficulties.** Groundwater problems are also complicated by a seldom recognized phenomenon: wells wear out. There is a general misconception that wells have very long lives. In actual municipal practice, wells drilled in sand and gravel formations have median service lives of about 17 years. Those drilled into the bedrock formations frequently last 50 years or more. There is need for recognition of the fact that wells decline in capacity, just as reservoirs do (due to sedimentation), and must be rehabilitated or replaced at intervals. The failure to recognize this fact leads many people to attribute water difficulties to water resources failures, when they are really attributable to aging of groundwater development facilities.

Well failure not only results from water-level declines, but also from improper or poor well construction, corrosion of screens and casings, plugging of the intake area of the well by fine materials, overloading the well or pump and pump failure.

### Floods

Although drought damage has been foremost in the minds of Illinois residents in recent months, floods, too, have been a recurring menace. Floods in Illinois have been recorded since the earliest exploration of the area and shall doubtless continue to recur in varying degrees of both magnitude and frequency.

In the present usage of the term, a flood occurs whenever the bank-full capacity of the normal stream channel is exceeded. This flooding may be caused by obstructions to flow caused by sedimentation, debris, ice, restrictive bridges and other works of man or runoff from the watershed in excess of the capacity of the normal channel. The usual watercourse consists of a

well-defined channel, usually relatively narrow and well entrenched, and bordered on one or both sides by a relatively wide and flat area known as the flood plain. The ordinary stream channel is usually capable of containing the low and medium flows from the watershed. The higher flows, however, overspread the channel and are carried by the flood plain, resulting in a flood.

Since Illinois residents have naturally elected to cultivate the fertile flood plain areas, to locate cities and industries along the watercourses and to convey arteries of land transportation across the streams, the natural periodic overflow of the normal stream channel onto the flood plain results in considerable damage. Perhaps unfortunately, it is only the larger and more spectacular floods that attract much attention and for which estimates of flood damage have been secured. The smaller and almost unnoticed "little" or headwater floods probably exact an annual toll equal to, or in excess of, the well-known large floods.

The following figures, while only estimates, serve to indicate the magnitude of damages in selected years from the larger floods:

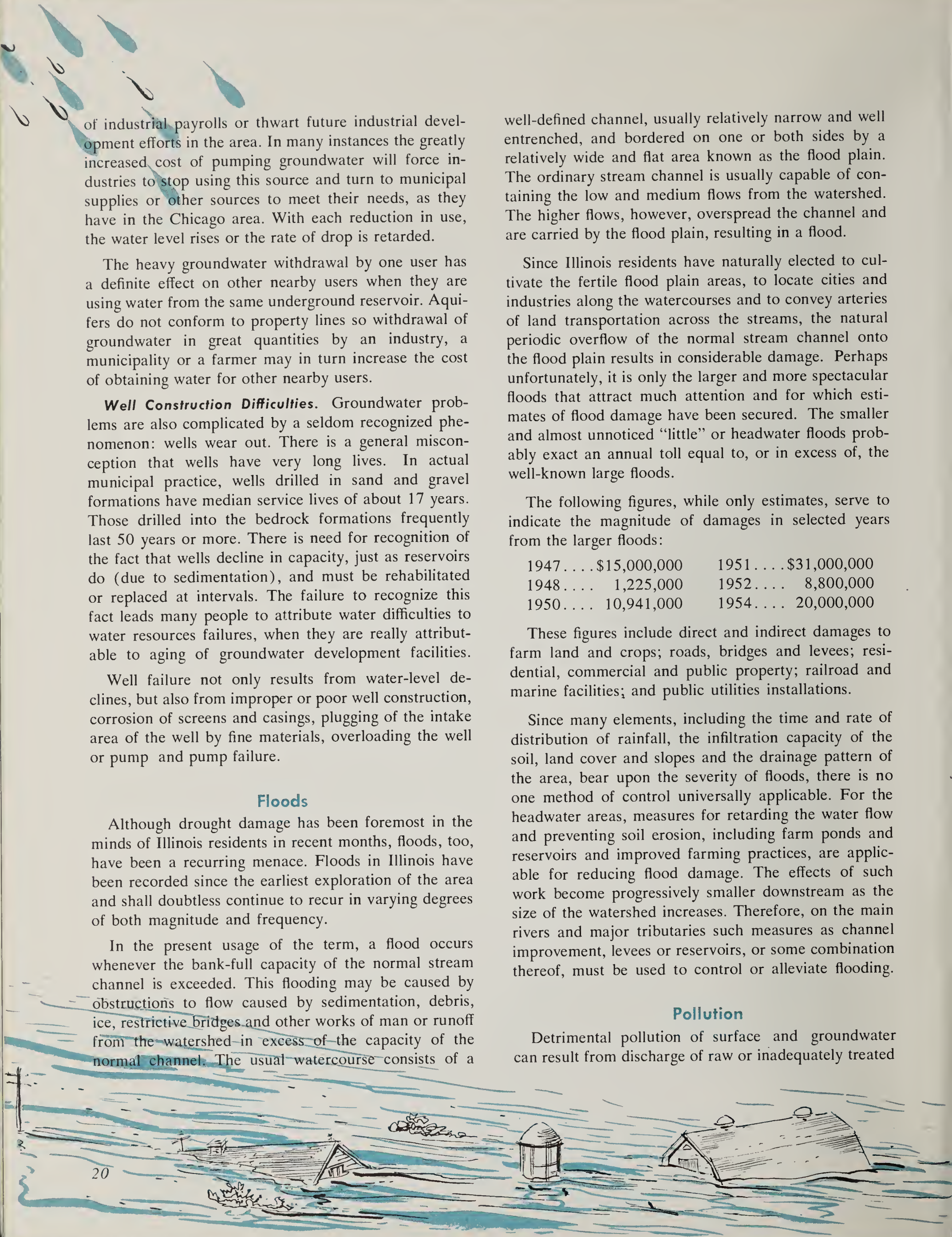
1947....	\$15,000,000	1951....	\$31,000,000
1948....	1,225,000	1952....	8,800,000
1950....	10,941,000	1954....	20,000,000

These figures include direct and indirect damages to farm land and crops; roads, bridges and levees; residential, commercial and public property; railroad and marine facilities; and public utilities installations.

Since many elements, including the time and rate of distribution of rainfall, the infiltration capacity of the soil, land cover and slopes and the drainage pattern of the area, bear upon the severity of floods, there is no one method of control universally applicable. For the headwater areas, measures for retarding the water flow and preventing soil erosion, including farm ponds and reservoirs and improved farming practices, are applicable for reducing flood damage. The effects of such work become progressively smaller downstream as the size of the watershed increases. Therefore, on the main rivers and major tributaries such measures as channel improvement, levees or reservoirs, or some combination thereof, must be used to control or alleviate flooding.

### Pollution

Detrimental pollution of surface and groundwater can result from discharge of raw or inadequately treated



sewage, industrial wastes or other undesirable substances into them. Pollution may be of organic or inorganic nature and occurs when any discharge renders a stream or body of water unsafe or objectionable for its natural uses. The Sanitary Water Board Act of 1951 defines pollution to mean "such alteration of the physical, chemical or biological properties of any waters of the State, or such discharge of any liquid, gaseous or solid substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish or other aquatic life."

Pollution can be a serious problem for industrial, agricultural, municipal or recreational users and affect the aesthetic beauty of the state. Seriously polluted waters may be of little or no value to other users downstream. Expensive treatment by municipalities and industries becomes necessary when their sources of supply become polluted. Bathing, boating and fishing can become impossible or undesirable through pollution.

Expanded industrialization and urbanization have increased the wastes being discharged into our rivers and lakes to such proportions that the natural purification capacity has been exceeded in several instances. Nearly every area in the state is affected by this problem in varying degrees due to various causes. Such wastes as grease, oil, toxic or organic materials and similar substances are particularly harmful to lakes and streams.

When the concentration of wastes in a stream becomes such a burden that the waste assimilation capacity is exceeded, the other functions of the stream become impaired and waste treatment is needed to abate stream pollution. Organic wastes can be stabilized and rendered harmless by bio-chemical action in properly designed plants. If sufficient water is available to dilute wastes adequately, many of them are in no way harmful. In periods of low stream flow, however, many normally adequate streams do not have sufficient volume to dilute the wastes enough to render them unobjectionable.

Treatment of sewage and wastes in municipal sewage treatment works or industrial plants removes much of the polluting matter from them and renders the final discharge stable so that a minimum of dilution serves to prevent undesirable stream conditions. Primary sewage treatment removes about 90 per cent of the solid matter or about 35 per cent of the polluting materials.

The Chicago Sanitary District removes over 770 tons of solids per day in its sewage treatment facilities.

Increased population, industrialization and the increased use of such modern conveniences as kitchen garbage disposal units have increased the burden on sewage treatment facilities. Household detergents as they are carried in the waste water interfere with the treatment process and are presenting new problems in sewage disposal.

The problem of inadequate waste collection and disposal facilities is becoming increasingly serious in many communities and should merit the careful consideration of each community which has outgrown, or is outgrowing, its present facilities. State regulation has forced many communities to take action to improve their waste disposal practices. In 1955, 77.6 per cent of the state's population was served by sewer systems. About 94.4 per cent of the municipal sewage was treated in sewage treatment works in that same year. Great strides have been made in this field, but increased demands being placed upon our present transmission and treatment systems will require continued attention to this matter.

**State Pollution Legislation and Regulations.** The Illinois Sanitary Water Board Act of 1929 was the result of popular demand for an effective program to control, prevent and abate the pollution of Illinois waters. Until 1929, a number of state departments had certain general and overlapping jurisdictions with regard to sanitation and conservation of waters, but the resultant confusing division of responsibility prevented fully effective programs of eliminating and preventing water pollution. The 1929 Act as later amended continued in force until it was replaced by a new but similar 1951 Act which also provided for a Sanitary Water Board. The board membership represents public health conservation, agriculture, industry and municipal government.

Certain board policies adopted shortly after the passage of the 1929 Act and continued in application to date include: a permit is required for any sewerage system or addition thereto which may receive domestic or industrial waste equivalent to that from 15 or more persons; permits are not granted for combined sewage and storm-water collection systems nor for combined sewer extensions to existing systems; no sanitary or industrial sewer systems nor extensions to an existing system will be approved where adequate treatment, disposal or by-product recovery facilities are not in-

cluded in the project or where the existing facilities are inadequate or are unsatisfactorily maintained or operated; approval of a treatment plant design for a municipality containing industry which may increase the plant loading in excess of the plant capacity shall not be granted until satisfactory written evidence is presented to the board that industrial wastes will not be allowed to enter the municipal sewerage system or that industry will provide separate treatment and disposal for their process wastes.

The Act provides that any person violating its provisions may be penalized not more than 500 dollars for the violation and an additional 100 dollars for each day during which violations continue, or by both such fines and imprisonment; and, in addition, such person may be enjoined from continuing such violation. The regulatory service thus provided makes possible the effective prevention of serious interference by municipal and industrial wastes with the downstream production of municipal water supply as well as permitting agriculture, industry and other users to enjoy the benefits of reasonably clean water without being forced to spend excessive amounts of money to reclaim usable water from degraded, polluted lakes and streams.

The essential program of sanitation of natural waters is never static and the pollution problem will worsen if slackening of effort is allowed. Population centralization, increase and shift, together with industrial expansion and process changes and an intensified agriculture, both accentuate and change the problem and require flexibility of treatment methods. Illinois law permits this state to protect its lakes and intra-state streams. Interstate compacts aid in the control of pollution of rivers and bodies of water on the borders of the state. Federal pollution abatement laws, if wisely written and applied to aid the state's laws instead of supplanting them, will help solve problems of interstate nature.

### Water Rights

The right to make unrestricted use of any water resource available to the user has generally been taken for granted in Illinois. However, in many of our western states where irrigation has to be practiced, water rights are by law clearly defined and strictly regulated.

The Illinois law dealing with water rights has been developed over the years by the decisions of our courts. Insofar as surface streams are concerned, our state,

from its early history, has followed the general rule of most civilized countries as to *riparian rights*. This rule holds that the owner of the land along or across which a stream flows does not own the water in the stream, but he has the right to make any reasonable use of it, having regard to the similar rights of all other riparian owners. It is the common right of all such owners to have the stream substantially maintained in its natural location, size and purity and to be protected against pollution or excessive withdrawal.

A well-defined but somewhat different rule is applied to surface water resulting from rainfall or melting snow flowing upon the land before it reaches a defined channel or stream. Here the land owner may use all of such water if he so desires. He may not, however, artificially prevent such water from flowing onto his land in its natural manner from the higher lands of his neighbor, and he may not deflect its natural flow or discharge from his land onto lower, adjacent lands.

As to percolating or groundwater, Illinois has thus far followed the English common-law rule that such water is as much a part of the land as the soil and the rocks or coal thereunder. The owner of the land owns the water. He may withdraw as much of it as he sees fit whether or not he makes any beneficial use thereof and regardless of the fact that such withdrawal may render his neighbor's well useless.

Because of greater demands for water by all user classes, water rights have now become a matter of increasing importance in Illinois. Our growing problems have led some observers to express the need for a reappraisal of our existing laws and the enactment of legislation defining priorities of use, providing for conservation and clarifying various other problems in this field.

Our State Legislature has from time to time over the past 75 years or so adopted various acts and created various boards and commissions to deal with certain specific water problems. Such legislation has dealt with such matters as flood control, drainage, navigation, stream pollution, wild life, sanitation, waterworks and sanitary drainage and water districts. The boards and commissions for the most part are authorized only to conduct investigations, collect data and make recommendations in their various and sometimes overlapping fields. None of these boards and commissions, however, deals specifically or directly with water rights. In gen-



**Figure 15.** High water condition at Rock Island, April 20, 1951.

eral, little provision has been made for a possible reconsideration of our laws pertaining to water rights as developed by the decisions of the courts.

In 1955, however, the 69th General Assembly authorized the appointment of the Commission on Water and Drouth Situation consisting of three members of the House of Representatives, three members of the Senate and five members appointed by the Governor representing agriculture, municipalities, conservation and wild life, public health and industry. It was directed to "make a thorough study of the water and drouth situation in Illinois and recommend legislation concerning surface and underground water and *the ownership, rights and privileges therein.*"

The Commission report is due to be made by February 15, 1957.

In 1945, the 64th General Assembly, in creating the State Water Resources and Flood Control Board for the purpose of making studies and recommending legislation for conserving our water resources and putting them to maximum use, recognized the existence of our growing water problems and also recognized the fact that our water supply is a valuable natural resource affected with a vital public interest. Section 1 of the

Act creating this board states the present public policy of our state as to our water resources, as follows:

*"It is hereby declared that the general welfare of the people of this State requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. The right to water or to the use or flow of water in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water."*

Some of the questions relating to water rights in Illinois are:

1. Should the water supply powers of local governments and special districts or authorities be increased?
2. Should a formalized system be established to

apportion available supplies to certain uses during periods of scarcity?

3. Should more state-wide control over unnecessary waste of groundwater resources be instituted?
4. Should bases or priorities be established for clarifying the rights to existing water resources and the costs of developing additional supplies among water users?

We are approaching the time when these and similar questions must be given careful consideration.

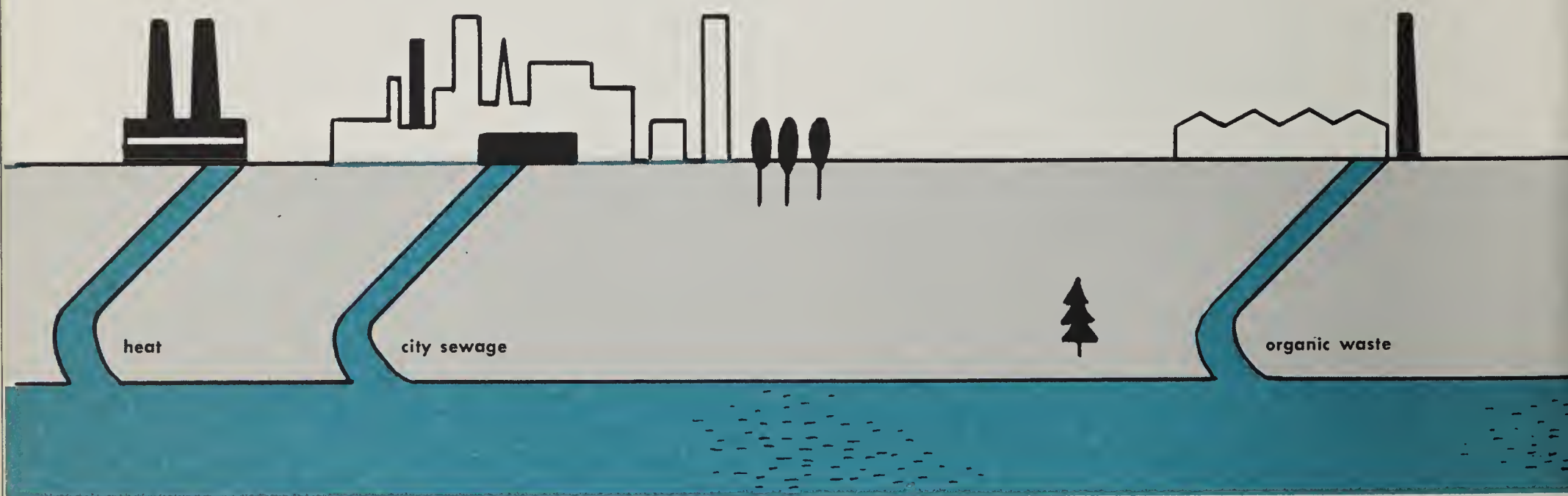
### Lack of Basic Data

The collection of basic data in Illinois on water resources has been considerably expanded since 1940, but most of the sources of supply which experienced shortages in 1952-1955 were constructed prior to this

date. They were designed on the basis of the data then available, which in many cases were insufficient to enable anticipation of the severe conditions that occurred in 1952-1955.

While there has been a considerable improvement in the collection of streamflow data and information on geology and fluctuations in availability of groundwater, there is still a substantial deficiency of groundwater information in areas where problems have not been experienced. Most of the groundwater study in Illinois has been concentrated in areas where problems have arisen. Further difficulties with water supply sources in Illinois must be anticipated in other areas of the state.

**Surface Water Data.** Illinois agencies charged with compiling data on surface water supplies have a vast amount of information available. In recent years, however, intelligent surface water development has been hindered in certain areas due to a lack of some basic



**Figure 16.** Effects of Various Pollutants. Heat discharged into stream raises its temperature. Evaporation will remove much of this heat during flow downstream. Heat pollution is only apt to be serious where a large amount is concentrated in relatively small flow.

Sewage, or other organic waste, is converted by microbes in stream, which consume oxygen in the process. Oxygen is used faster than it is replaced by aeration, etc., and stream's oxygen content drops. Fish, vegetation, etc., dependent on it die. Worst "pollution" is at point of lowest oxygen content. Then, as oxygen demands are satisfied, and re-aeration gains, stream's oxygen content builds up. If not further polluted, it purifies itself in time.

data. Additional information in the following fields is badly needed:

1. Stream flow
2. Precipitation
3. Sedimentation
4. Evaporation

**Groundwater Data.** Adequate quantitative data to accurately evaluate potential maximum groundwater production from any specific area of the state is not now available. State agencies have been collecting such data in several areas for many years, but this work should be continued and expanded so that proper information will be available when it is most needed.

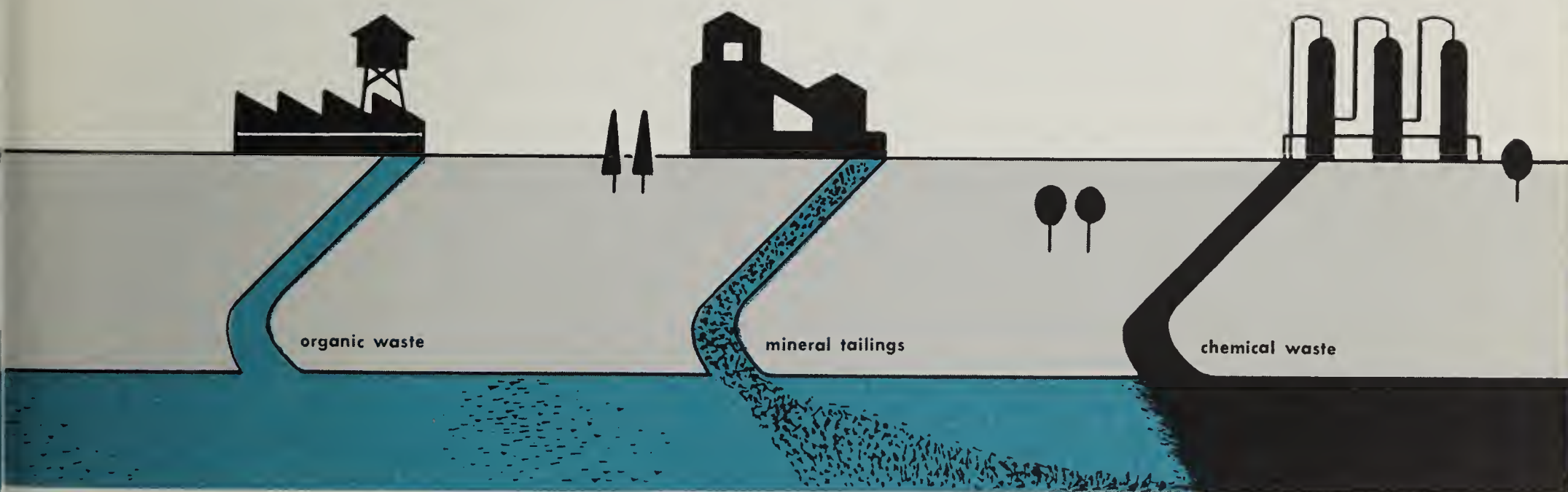
Most critically needed data include:

1. Basic geologic studies on the occurrence, extent, physical characteristics, environment and limitations on artificial recharge of aquifers.
2. Basic hydrologic studies to determine the potential yield and engineering methods of devel-

opment and artificial recharge of aquifers. Such studies should include a state-wide water level observation program.

3. Basic chemical studies of water quality and mineral composition of aquifers.
4. Groundwater inventories of areas of large and concentrated groundwater withdrawal such as the Chicago, East St. Louis, Fox River Valley and Peoria-Pekin areas, and other areas of potential large development.

Systematic collection and filing of scientific information such as well logs, water levels, pumping data, water analyses and earth samples are undertaken by the state scientific surveys. The availability of this type of information gives a strong foundation on which to make detailed studies of groundwater. But these data alone are seldom sufficient for thorough groundwater investigations.



*Organic Waste* discharges may come close together in industrial centers. Natural forces of the stream may be able to make some recovery between pollution sources, but if load is too great, situation may become hopeless.

*Mineral tailings* and other insoluble materials slowly settle out of stream but the resulting bottom coating, if it's dense enough, may smother useful purifying micro-organisms and spawning and breeding places of stream life.

*Chemical wastes* take a wide variety of forms. If they're soluble and not oxygen-consuming, they remain in solution as the stream flows along. How serious such pollution is depends on the nature of the chemical discharged.

Only with adequate data and modern methods of exploration and evaluation can individuals and communities in Illinois circumvent expensive and otherwise critical groundwater supply failure in the future and plan efficient conservation programs. Further collection and analysis of such data undoubtedly will bring to light more efficient avenues of utilization of Illinois' most valuable renewable resource.

### HOW CAN OUR WATER PROBLEMS BE SOLVED?

None of the problems now facing Illinois water users are without solution, and almost all of them can be solved on a local level. Community and area leaders and organizations should first assume the responsibility for having an inventory taken of the problems they and their localities face and, after careful study, making certain that the necessary steps are taken to solve these difficulties.

Ideally, solution of these problems depends on:

1. Definition and understanding of the problems by use of existing data and by gathering additional needed data.
2. Analysis of these problems by competent technical people.
3. Determination and application of the proper action for each problem by competent technicians.

The importance of careful planning of any program has been emphasized in all successful approaches to various water resources problems studied by the State Chamber. By thorough investigation of the quality and the quantity of requirements needed and by planning and development of supply utilization in cooperation with other users, any present user class will be able to meet its needs adequately in the foreseeable future.

The money and time spent planning any water supply improvement will be returned many times over in dividends of adequate facilities. Competent consulting engineering firms can be engaged to make studies of available water resources and problems of communities and industries and recommend suitable remedial action. Qualified state and federal soil conservation specialists will assist farmers plan sound water and soil conservation programs for their farms. Many local, regional and

state organizations and government agencies are available to give assistance to all users in meeting their difficulties of proper water supply. Following are some approaches recommended by the State Chamber for solving Illinois' water problems.

### Upper Watershed Activity

Water must pass across, into or through the soil. It has been shown that best conservation practice is to properly protect this natural cover and reservoir by proper land use including contour farming, terracing and gully control, strip cropping, reforestation and construction of farm ponds and grass waterways. Soil and water conservation such as this induces more water into the soil and thus increases storage in the soil moisture and groundwater reservoirs, reduces flooding and erosion, and maintains a higher dry weather or base flow of streams.

Watershed organizations and soil conservation districts have had amazing success in some areas in reducing soil erosion and siltation and improving the quantity and quality of available water supplies. The success of these organizations has been almost in direct proportion to the percentage of farmers in each watershed or district cooperating in these programs and the degree to which these farmers are participating in carrying out their part of the over-all effort. Proper soil and water conservation programs have reduced sedimentation from 50 to 90 per cent in some watersheds and at the same time have been highly profitable to the farmer. The State Water Survey has recommended this approach to reducing the degree of sedimentation damage to every reservoir and lake studied by that agency.

Illinois soil conservation districts have made great progress, but there remains a need for further stimulus in this field. The officers of the districts are anxious to improve their effectiveness, but most of them admit they need assistance in encouraging greater interest and desire of farmers to participate. A great service can be rendered by those groups that will conduct an effective educational and promotional program in behalf of soil and water conservation on a local level.

Outside groups and individuals have often given impetus to the program of a soil conservation district. They have either promoted the formation of such organizations originally or aided them in expanding their effectiveness after they were formed. Sponsorship of soil conservation contests and courses, financial assistance

and recognition programs have proved effective. Programs designed to help convince individual farmers of the need for soil conservation and to assist them to carry out a good soil conservation plan are basic approaches to the problem, and more of them are badly needed. A program of this type has been highly successful in raising farm income in the St. Joseph, Missouri, area.

Illinois statutes authorize the formation of the following units of local government to deal with area-wide problems of soil and water conservation:

1. Drainage Districts and Levee Districts
2. Public Water Districts
3. River Conservancy Districts
4. Soil Conservation Districts
5. Surface Water Protection Districts
6. Water Authorities

These bodies, properly organized and supported, have the power to meet many difficulties related to prevention of floods, pollution, erosion, water waste and other problems. A greater interest in their efforts by rural and urban citizens alike would produce extremely beneficial results.

Some cities have found it necessary to purchase severely eroded land situated in their watersheds to protect their reservoirs. These areas have been reforested or leased to farmers under strict stipulations as to land use and conservation practices to be followed. The City of Akron, Ohio, owns 8,000 acres of such land in its watershed and shows a profit from the farms leased to private operators. Other cities have used this land for parks and recreation areas. These examples might be followed with equal success by several Illinois communities relying on surface water for their source of supply.

### **Municipal Action**

**Survey-Plan-Act.** Comprehensive studies of local water resources, problems and possible solutions are needed in many Illinois communities as the first step toward assuring adequate water supplies for all users in those communities. Out of these studies would come plans and action which will eventually eliminate existing and approaching difficulties. Chicago, Bloomington, Mattoon, Peoria and Effingham are among the communities which have had such surveys made recently by competent engineering firms. By such studies, communities can determine what their basic difficulties are

and make preparations to meet the increased demands future progress will bring.

**Examples of Effective Action.** Many examples of successful attempts at solving local water problems are readily available in Illinois. Outstanding action of various kinds has been taken in recent years by Peoria, Jacksonville, Decatur and several other Illinois cities. In 1955, Jacksonville finished construction of a 23-mile pipeline to a collector type well constructed beside the Illinois River at a cost of \$2,750,000. The project was financed without federal aid and is expected to solve a 100-year-old problem of water shortage.

Through the cooperative efforts of the Peoria Association of Commerce, the State Water Survey and the municipalities, industries and utilities in the greater Peoria area, a comprehensive survey has been made and a long-range program is now going forward to solve the water problems of this area. Infiltration pits designed to replenish Peoria's groundwater supplies with water from the Illinois River have been remarkably effective and have attracted nation-wide attention. Community leaders secured the services of a competent engineering firm to make a detailed study of the existing water resources of the area and recommend a program for replenishing those resources. This comprehensive report provides a guide to sound solution of serious problems which have plagued Peoria and nearby towns for many years.

The City of Decatur has followed a two-pronged attack on its water problem. The city faced increased demands for water at the same time its reservoir on the Sangamon River was being seriously injured by sediment from upstream land. For several years the city has employed a conservationist to encourage the installation of conservation practices on the land in the upper watershed of the Sangamon River to reduce sediment damage. A thorough review of the present and future water requirements in this area was initiated; plans for expansion of facilities to meet these requirements were prepared, and the necessary work is now under construction. A short-term emergency source of supply was developed to be available during the planning and construction period.

Among the many other cities which have expended huge sums during the past few years to bring their water source development, plant, storage or transmission facilities up to date are Bloomington, Shelbyville, Mt. Carmel, East St. Louis, LaSalle, Granite City, Sandoval

and Melrose Park. Permits for water improvement projects issued by the Division of Sanitary Engineering rose from 385 in 1952 to 741 in 1955, a definite indication that many communities have taken the action needed to solve the difficulties they face.

Action to conserve water may take many forms. For example, the water company serving Champaign-Urbana recently found it necessary to institute an annual surcharge of \$25 per ton of rated refrigerating capacity of water-cooled air conditioning units when the user fails to make arrangements to re-use water needed for this equipment. The surcharge becomes effective in 1957 and will be increased to \$35 per ton in 1958 and \$40 per ton in 1959. This failure to practice conservation was considered to be a gross waste causing considerably more expense to be incurred by the water company in providing the additional supply of water to meet a peak demand usually lasting only about two months. Similar action has been taken by the companies serving the Danville and Evanston areas.

**Types of Action Needed.** Thorough surveys have sometimes indicated the need for additional wells or reservoirs, development of entirely new sources of supply, new treatment and pumping facilities, extension of or replacement of mains, reduction of leakage and waste in the distribution system, accurate metering of water sales, increased rates or other action. Often, problems of various kinds have been discovered or brought into their proper light by these surveys in areas where none were thought to exist.

For example, two items listed above, reduction of leakage and waste in the distribution system and accurate metering of water sales, are normal elements of every good management program and are too often neglected. Good management of a water system generally results in a maximum of 10 to 15 per cent unaccounted-for water. (Unaccounted-for water is the difference between the amount of water pumped into the community's mains and the amount of water sold or deliberately furnished without charge.) Many Illinois communities have found their unaccounted-for water exceeding 50 per cent of the amount pumped from the city's works, largely due to leaks in water mains and service connections to homes, but frequently due to under-registration of meters. Aggressive leak-detection programs can cut this waste dramatically, but must be followed up by a regular program of continuous leak-detection to keep the unaccounted-for amount small. An example of what

can be done is provided by the City of Brookfield where \$30,000 was saved in one year by reducing water leakage.

Faulty meters or lack of meters are also common causes of serious losses of water. Many public water companies in Illinois do not meter all accounts, and a large proportion of the remaining companies expend little effort to keep meters in good operating condition. Installation of a meter on every service is highly desirable as a means of accounting for water and discouraging waste. It is essential that these meters be kept in good operating condition. This requires routine testing of meters at intervals not greater than seven years, and preferably more often. Such programs may seem to add to the expense of operation of the water works system, but they actually save money through reduction of waste and unaccounted-for water.

As a matter of general practice, every water supply system should have the demands it faces and its capabilities evaluated at least once each decade. This will be particularly important during the coming few years as all user classes increase their demands for water. The problem of estimating growth has been a common one which must be continually met.

**Financial Problems.** Frequently, the cost of providing adequate water facilities is seemingly tremendous. On the other hand, the future economic development of many Illinois communities depends greatly on what is done now to meet these costs and to provide adequate water supplies to meet projected needs. Some communities judged to be ideal locations for new industry have been eliminated from consideration only because developed water supplies or facilities were inadequate.

The financial problems of some communities tend to discourage or postpone taking the costly measures often necessary to solve pressing water problems. The need for adequate water supply is so basic, however, that improvements in this field should be given a high priority in community budgets.

**Need for Greater Citizen Interest.** As a result of the drought of 1952-1955, many cities, towns and villages in Illinois addressed themselves to their water problems and have taken the action necessary to solve them. Other communities again assumed their complacent attitude when their reservoirs or wells filled. Still other communities which were not compelled by drought to face their problems squarely are still not officially con-

cerned about, or even aware of, the difficulties they face.

Citizens and organizations in the latter communities should urge their local governments to evaluate their water supply needs and insist upon adequate solutions to their problems. Water resources committees of several local chambers of commerce throughout the state have performed a real service by demonstrating the need for community action and leading efforts to solve serious water problems. Greater activity of this kind by other chambers, business firms, civic organizations and individuals can be expected as they become more fully aware of the nature and extent of the problems in their localities.

### **Industrial Water Conservation**

Many Illinois industries have done much to relieve some local water supply difficulties by adopting various conservation measures to a greater degree. Their efforts have included minimizing both water demand and quality impairment. However, industrial processes generally have required increasingly larger quantities of water.

**Minimizing Demand.** In areas where heavy groundwater use has lowered the pumping levels, industries have begun using water from surface sources for those processes where it has been possible to make the substitution. Some industries requiring water of lower temperature have been able to substitute surface water in winter and revert to well water during the summer. Also, impure water has been substituted for water of higher quality in certain industrial uses where purity is not a necessary characteristic. A plant may have several transmission systems for water of varying quality or temperature.

Re-use techniques have been employed in many processes. Provision has been made for cooling ponds or towers or other water-saving devices. Savings of from 90 to 95 per cent can be effected by use of a closed cooling tower system. To reduce water needed for cooling purposes, heat dissipation has been accomplished by evaporative cooling techniques and to a lesser extent by use of mechanical cooling devices or by transmitting it directly to the air.

Reduction of waste by employees and faulty equipment can enable tremendous savings of water to be made. Thorough control programs directed by an experienced supervisor can result in economical water use by such means as eliminating leaks in distribution sys-

tems, faucets, sanitary fixtures, drinking fountains, etc.; regulating flow of water in cooling processes to amount actually needed; metering; protecting piping against freezing; and similar measures.

Examples of excellent results from such efforts are numerous. By replacing 117 water fountains that flowed continuously with standard fountains, one plant has effected a saving of 30 million gallons of water annually. A leak survey made recently in a large steel mill revealed losses amounting to over 3 million gallons daily from that cause.

Individual plants must remain competitive with others in their field, and conservation of water can be practiced only until costs of doing so become prohibitive. As demands on our existing water supplies increase, however, greater attention must be given to conservation measures. In many instances management will find this conservation actually saving money rather than being an added expense.

**Pollution Abatement.** Pollution of water supplies by industries has been reduced by greater treatment of waste before it is discharged into the various bodies of water, better housekeeping and changes in some processes. Restrictions have been placed on the direct introduction into our streams of such objectionable industrial wastes as grease, hair, plating residues and acids. Some plant wastes are disposed of by other means than by flushing them into streams. Efforts to reduce pollution are as important as other water conservation practices because pollution can deprive many other users of the water's availability.

At one time industries in the Peoria area were responsible for the discharge into streams of waste equivalent to that of a population of over 2,000,000. This serious menace has largely been removed now through the cooperation of these industries. Approximately 95 per cent of the organic load of the industrial waste of that area has been removed, much of it at individual plants. Similar results have been achieved in other areas in the state.

The problems related to industrial waste disposal have not been as serious in Illinois as they have been in other states because of the early realization of their seriousness and the determined efforts made to solve them. Problems arise, however, as new processes are developed or old ones are changed. For this reason it is important that industrial leaders continue to diligently

search for suitable and fair solutions to these industrial waste problems.

Although great strides have been made in industrial water conservation and pollution abatement, dissemination of additional information and further encouragement in this field still would result in further improvement.

### State Government Action

Local initiative and autonomy in water resources planning, development and control should be maintained and encouraged. State agencies should provide leadership and guidance to local efforts and regulate only when absolutely necessary to protect the interest and well-being of the general public. By foresight and initiative on the part of the state government, federal action need not be called for except in matters of an interstate character.

*The Illinois General Assembly should authorize and provide funds for a thorough survey of*

*Illinois water resources, uses and problems and agencies dealing with these matters.*

**Analysis of Resources, Uses and Problems.** A thorough analysis and report on the nature and extent of Illinois' water resources, present and expected future demands on them and resulting problems is vitally needed and should be undertaken as soon as possible. Failure to do so may cause recognition of basic difficulties to be postponed until they develop into even more serious ones and their solution becomes more expensive and troublesome.

A great deal of valuable technical information is available in bulletins, reports of investigations and unpublished data of the various state agencies, but it has not been assimilated, evaluated, interpreted and summarized in proper form in one comprehensive report. Additional special investigations might be necessary to supply basic data needed to complete the report. An example of the review type of study needed is provided by "Water in Kansas," submitted by the Kansas Water

**Figure 17.** Elaborate and expensive facilities such as those shown below are needed to procure, treat and transmit water to customers of municipal water systems.



Resources Fact-Finding and Research Committee to the Kansas State Legislature in 1955.

Although the staffs of existing state agencies could be drawn upon to a considerable degree, a special staff of highly competent personnel would probably have to be engaged to coordinate the compilation and preparation of the report. Appropriations to cover the cost of hiring this staff as well as their expenses, printing costs and secretarial assistance would be needed. Authorization to make the study should be given early in the 1957 Session of the Illinois General Assembly so that it can be undertaken as soon as possible.

No legislation relating to the state's water resources should be enacted on the basis of inadequate information. The proposed study would reveal areas of current and future water resource problems and provide an indication of the course state action should take in this field.

**Review of Agency Responsibility.** The areas of responsibility and duties of state agencies dealing with matters related to our water resources should also be thoroughly reviewed in this survey. The study would reveal whether any clarification of responsibility or coordination of activity is needed in order to insure the most effective and efficient handling of water resources matters.

Illinois is fortunate in having water resources agencies which are the envy of many other states. The work done by these agencies in many research, advisory and regulatory capacities has been outstanding. There has been the feeling on the part of several authorities, however, that some shortcomings do exist. For example, it has been suggested that improvement could be made in the speed and effectiveness with which some necessary regulatory and investigatory functions can be exercised. It has also been suggested that certain areas of research and advisory activity have been inadequately pursued. A thorough review of the area of responsibility and duties of all agencies dealing with water supply matters might reveal whether these criticisms are actually merited and, if so, how these, and any other difficulties uncovered in the study, might be remedied.

Such a study would also indicate whether there is any need for greater cooperation among the agencies, more coordination of their activities or clearer definition of over-all goals or policies. As the demands on our water resources increase, it becomes increasingly more impor-

tant that agencies charged with the responsibility for dealing with them not be hampered by problems of organization which lead to duplication of effort or the inability to efficiently, effectively and quickly carry out their functions.

***No legislation relating to water rights should be adopted unless a thorough study of this problem is made and the interests of all user classes considered.***

This problem is of vital interest to all user classes. It should be approached with considerable caution to insure that even more serious situations than any now existing are not fostered by premature or unwise legislation. Consideration must be given to existing water rights laws and such physical factors as the amount, location and extent of our ground and surface water resources. Consideration must also be given to such economic factors as the cost of utilizing available ground or surface water for various purposes in different areas, the current and expected future demands for all users, and the importance of various uses to the economy and well-being of the citizens in different areas of the state.

## **MAJOR STATE AGENCIES DEALING WITH WATER RESOURCES**

Although there are several state agencies available for consultation on many types of local water problems or which have a major responsibility for the development, protection and preservation of our water resources, the services they provide and the functions they perform are not generally understood. The agencies discussed in this section are among those most responsible for research, advisory functions, over-all planning and enforcement of state statutes relating to our water resources.

Consultation with members of the staffs of appropriate research, advisory and enforcement agencies will be beneficial to persons considering solutions to their local problems. A better understanding of where the responsibility for over-all planning or enforcement rests is necessary in order to assess the need for granting additional powers or broadening the scope of activity of any particular agency or encouraging it to fulfill its duties and responsibilities adequately. This discussion is not meant to include all state agencies having to do with water resources matters or provide a complete list of

their duties. Several federal agencies also perform valuable services in this field but are not included here.

**1. State Water Resources and Flood Control Board, Springfield.**

The board is composed of the directors of the Departments of Conservation, Public Health, Registration and Education, Agriculture and Public Works and Buildings. Broad general powers have been granted to this board in the interests of maximizing the beneficial uses of state water resources. It is its duty to study, investigate and determine ways and means to coordinate uses of water so that the greatest possible benefit can be derived from them. It is responsible for making general state water policy recommendations and, to some extent, coordinating the work of various agencies dealing with water problems. It has authority to recommend water conservation legislation to the State Legislature; to make necessary rules and regulations and require any state agency or department to make investigations and prepare reports it deems necessary to carry out the provisions of the State Water Resources and Flood Control Board Act; to represent the state (subject to the approval of the Governor) in negotiations with the United States or its agencies with regard to any federal projects affecting Illinois watercourses or watersheds; and to provide for arbitration and adjustment of conflicting claims and rights to water resources by various users or uses.

**2. Water Survey and Geological Survey Divisions of the Department of Registration and Education, Urbana.**

The Water Survey engages in study of many phases of the nature and extent of state water resources, including siltation of water impoundment reservoirs, groundwater levels, precipitation, surface water supplies and stream gauging. Information on the mineral quality of water and engineering information about well yields and water levels can be secured from this source. The Geological Survey deals with the geological aspects of groundwater supply. These two agencies work closely together and have a storehouse of information available to all interested persons on most aspects of local water supplies.

**3. Division of Waterways of the Department of Public Works and Buildings, Springfield.**

This agency has general supervision of all public bodies of water in the state (those lakes, streams, canals and rivers not owned by private interests, municipal

corporations or the United States Government). It administers more than 50 laws and regulations which protect the public interests in these waters. It regulates construction in public waters, prevents obstruction of navigation in navigable watercourses, supervises planning and construction of flood control works, operates moveable bridges over the Illinois Waterway and makes general surveys and investigations of Illinois watercourses.

**4. Sanitary Water Board, Springfield.**

This agency is charged "... to control, prevent, and abate pollution of the streams, lakes, ponds, and other surface and underground waters in the State, ...". Among the functions of the Sanitary Water Board are: reviewing plans and specifications for proposed domestic and industrial waste treatment works operation, making necessary investigations and reports upon natural waters, and all other activities pertinent to a successful stream sanitation and conservation program.

**5. Division of Sanitary Engineering of the Department of Public Health, Springfield.**

Included among other activities, this division acts in supervisory capacity relative to the sanitary quality, mineral quality and adequacy of proposed and existing public water supplies, treatment and purification works. The division also supplies the technical staff for the administrative activities of the Sanitary Water Board.

**6. Division of Oil and Gas of the Department of Mines and Minerals, Springfield.**

This division has jurisdiction over pollution of land and water resulting from oil field operations and issues permits for rock water wells.

**7. Division of Forestry of the Department of Conservation, Springfield.**

Through this division rural landowners can secure the advice and assistance of district foresters in planning reforestation of eroded or idle land. Ten million forest tree seedlings and shrubs were distributed during the 1955 growing season by the division for the profitable rehabilitation of land and the provision of a better haven for wild life.

**8. Division of Soil Conservation of the Department of Agriculture, Springfield.**

Trained conservationists from this division work closely with the local soil conservation districts and with federal conservation representatives in advising on local conservation matters.



**Figure 18.** Huge quantities of water are required for many industrial processes, but real opportunities exist for reducing waste and pollution of available supplies.

## SUMMARY

Water is a primary human necessity for which there is no substitute. The State of Illinois is fortunate in having adequate resources of water to meet all needs, but is faced with increasing difficulties of distribution and quality. Early action based on a thorough understanding of the nature, use and extent of our water resources is necessary to insure continued, unimpeded progress of our state.

Problems have arisen because of increased use of water for agricultural, municipal and industrial purposes. Nearly all of these difficulties can be solved on a local level and programs have been developed which can be used as desirable patterns for local action. Local, state and federal government agencies and private organizations are available to aid the work of far-sighted individuals and organizations in developing and carrying out workable solutions to meet local problems.

Consultation with qualified experts and careful planning are highly important in the development of sound solutions to our water problems. Too often, the most apparent solution is not the most effective and the least

expensive method is not the most desirable over the long run.

It is the hope of the Illinois State Chamber of Commerce that individual local leaders, community organizations, businessmen and local governments will take the initiative necessary to solve existing and imminent problems on a local level. The state government should provide needed clarification and leadership in matters of a state-wide nature.

These efforts on state and local levels will be supported by the State Chamber's Water Resources Committee. This newly formed committee is composed of outstanding authorities on all phases of water resources development, use and control who are concerned with the need for greater attention to our problems in this field. The committee's program includes providing needed stimulation, leadership and guidance to efforts to solve local water problems and working for desirable legislation and administrative action on state water resources matters. The committee will work for equitable and effective solutions of the water problems affecting the state and the most beneficial use possible of our available water resources.



# WATER SUPPLY

## ACKNOWLEDGMENTS

Acknowledgment is made of the valuable assistance and cooperation received in the preparation of this report from many individuals, private organizations and governmental agencies. Particularly helpful state agencies were the State Water Survey and Geological Survey Divisions of the Department of Registration and Education, the Division of Sanitary Engineering of the Department of Public Health and the Division of Waterways of the Department of Public Works and Buildings.

In addition to members of the State Chamber's Water Resources Committee many other experts in specific fields encompassed in the report were consulted. Dr. George B. Maxey, Geologist and Head of the Division of Groundwater Geology and Geophysical Exploration

of the State Geological Survey and Herbert E. Hudson, former Head of the Engineering Subdivision of the State Water Survey, have devoted considerable time to providing valuable guidance and assistance in the preparation of this report.

Figures 1, 4, 8, 9, 11 and 16 and their captions were reprinted from a special report on "Water" in *POWER*, a McGraw-Hill publication. Figures 3, 5, 6 and 7 were supplied by the Illinois State Geological Survey; 2 and 10 by the State Water Survey; 12, 15 and 18 by the Corps of Engineers, U. S. Army; 13 by the State of Ohio Department of Natural Resources; 14 by the Illinois Agricultural Association; and 17 by the City of Chicago Department of Water and Sewers.

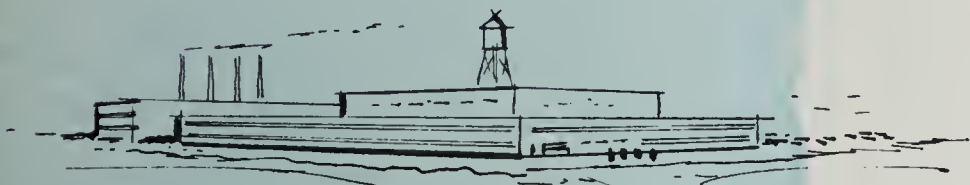
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ILLINOIS WATER SUPPLY :  
 A VITAL NECESSITY, A  
 GROWING PROBLEM.

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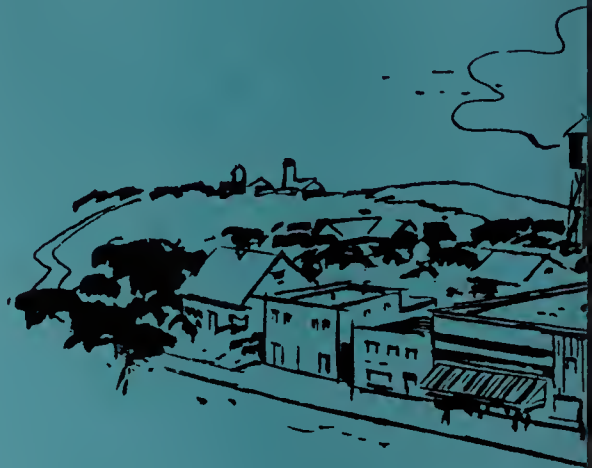
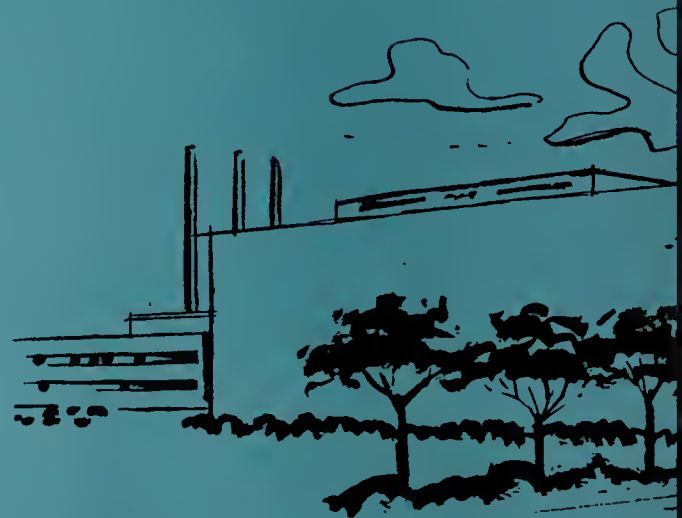
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